

# The Dock and Harbour Authority

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## Editorial Comments

### Leixoes and Oporto.

The fact that Portugal is a staunch friend and ally of Great Britain and has a distinguished record of maritime enterprise and overseas colonisation, should enhance to readers in this country the interest of the leading article and Illustrated Supplement on the Harbour of Leixoes which appears in this month's issue from the pen of Senhor Duarte Abecasis, the Engineer-in-Chief of the works.

Closely linked with Oporto, the second city in Portugal, of which it is the seaport, its function is to receive shipping which cannot penetrate into the River Douro, the mouth of which is obstructed by a sandy spit of land accentuated by deposits of river silt. The harbour has an enclosed area of over 200 acres, with an entrance depth of as much as 50-ft. The enclosure is formed by means of an outer breakwater or mole, which, however, has suffered severe storm damage in recent years. The vertical type of wall having proved unsuitable to withstand the heavy seas which are experienced in the locality, a revision of design has been under consideration, accompanied by an experimental investigation of no little importance and interest to maritime engineers. Following the articles recently appearing in this Journal on International Studies on Wave Force, the conclusions arrived at from these experiments are an appropriate and extremely serviceable addendum to the available data on the subject.

The foreign trade of Oporto is largely in British hands, and a considerable number of ships call at Leixoes en route between Lisbon and Liverpool, London and Southampton. Indeed, as the capital of northern Portugal, Oporto is a redoubtable competitor with Lisbon in commercial and maritime affairs. Perhaps the most notable article of commerce is port wine which, produced from vines grown in the Douro district, is exported in considerable quantities.

The city of Oporto has also figured in British military annals. The city was captured from Marshal Soult in 1809 by the Duke of Wellington, when he forced the passage of the Douro and routed the French general. The co-operation of Portugal and Great Britain is, however, more happily instanced in their commercial relations, and it is to be hoped that the increased accommodation which is now being provided will add appreciably to the intercourse of trade, which is the main desideratum of ports all the world over, and so strengthen the existing ties between the countries in a peaceful and harmonious manner.

### Port Health Authorities' Conference.

The Annual Conference at Middlesbrough of the National Association of Port Health Authorities brings into well-merited prominence the important part played by these bodies in the safeguarding of the country from the possible introduction of disease from foreign sources. Without the constant care and watchfulness exercised by Port Medical Officers and their staffs, the danger of infection at ports would be considerably increased, and there would be a constant menace of epidemics, which, if once started, might be difficult to eradicate, or even control.

In a succeeding issue, we hope to have the privilege of reproducing an informative address recently delivered in New York by Dr. C. V. Akin, the chief quarantine officer at that port, which will describe the precautions taken there in regard to ship sanitation and its influence on the granting of Pratique, more particularly Radio Pratique, which has now definitely come into

vogue and is proving of valuable assistance in quarantine routine. Developments in overseas traffic of recent years have made the duties of port sanitary officials more exacting and their responsibilities more onerous, but the commendable manner in which these duties are carried out and the regulations rigorously enforced, is sufficient to reassure the public as to the effectiveness of the safeguards provided.

Conferences, such as that at Middlesbrough, serve as a valuable means for the dissemination of views and the pooling of knowledge in a department of port affairs which is of the utmost importance to the nation at large. Among the subjects under consideration were the alleged insanitary conditions on coastal vessels, the desirability of controlling imports of animal products used in the manufacture of drugs, and the effects of river pollution on public health. Attention was directed to the imperfect supervision of imported foodstuffs, and loopholes were pointed out in the administration of the Public Health (Imported Food) Regulations 1937, owing to the distinction between the functions of a port health authority and those of a local authority. The port health authority is not concerned with the correct and proper designation of foodstuffs, that being the duty of the local authority charged with the administration of the Food and Drugs Act in the area of the port health authority. Because the area of the port health authority is often co-terminous with that of the customs authority, and consequently not easily accessible, local authorities tended to neglect this part of their area in discharging their duties as regards inspection of foodstuffs. Foodstuffs, it was stated, sold by retail shops in dock areas, were seldom subjected to sampling by the food and drugs inspector, and even if inspection took place, the inspector "might hesitate to take action for the simple reason that it is not part of his duty, and he might even be told to mind his own business." If this is the case, it is time the Ministry of Health turned their attention to the matter. No tampering with or oversight in regard to official regulations should be permissible, and the sooner the position is clearly defined the better.

The President of the Association, Alderman Stanley Sadler, Chairman of the Tees Port Health Authority, declared in his address that three-quarters of the people of Great Britain had no conception of the work of the Association. It was, however, doing vital service, and since its formation in 1898, had contributed effectively to the strengthening of health services at British ports. Of 62 port health authorities in England and Wales, 42 were members of the Association, but in Scotland only seven out of 40 had joined. An appeal was made for an extension of membership, particularly among the smaller port health authorities. This appeal should meet with a ready response, in view of the important national interests which could be served by a well-supported Association.

### Foreign Trade Zones at United States Ports.

In our May issue we commented on the importance which the movement for the establishment of Foreign Trade Zones, or Free Port Areas, had acquired in the United States, pointing out that these zones had recently been the subject of two papers read before the Pacific Coast Association of Port Authorities. We, however, felt at the time that the grounds on which the movement was advocated were not altogether convincing, and that many of the advantages claimed for Free Port Areas could be gained by simpler means. The prevalent and underlying idea in American port circles appears to have been that the assignment of a free port area would lead to an increase of

*Editorial Comments—continued*

foreign trade. This, however, is not necessarily the case, and evidence has been accumulating that the two free ports already established in the United States have not by any means fulfilled expectations. The returns from the Foreign Zone at Staten Island, New York, have not been encouraging, and lately has come the intimation of the discontinuance of operation of the Foreign Trade Zone at Mobile, Ala., under instructions from the United States Department of Commerce. The zone was only created last year, but it has been operated at a loss, and the experiment is judged to have failed. In place of the zone, the site on the Alabama State Docks Commission area assigned to the purpose has been converted into a manipulating, or bonded, warehouse. Readers of our comment in the May issue will recall that two of the advantages claimed by Mr. Lyons, the Executive Secretary of the Foreign Trades Zones Board of the Department of Commerce, Washington, were therein stated to appertain equally well to the Bonded Warehouse.

**Buenos Ayres Port Development.**

In our issue of April last, we reviewed the outline of a project for the reconstruction of the Port Authority at Buenos Ayres. Now, it is announced that schemes are in contemplation for the enlargement of the port itself, more particularly in providing additional facilities for the coastal and river trade, for which the present accommodation is proving inadequate. Plans have been prepared for the construction of a group of basins with certain adjuncts, to serve the passenger and goods traffic proceeding from the Rivers Parana, Paraguay and Uruguay, from Monte Video and Colonia and from the south coast (Argentine Atlantic). The new basins will be located at the mouth of the River Riachuelo, in the southern outer harbour of the port.

The designs prepared by Mr. Ernesto Baldassari, Chief of the Directorate-General of Navigation and Ports, envisage procedure in a series of three stages, the first of which will comprise the construction of three basins, three intermediate piers, or arms, for the reception of roadways, railway sidings and shed accommodation, a passenger station for river services, two embarkation quays for motor ferries, refrigerated storage accommodation for fish and fruit, and other features. The second stage will comprise the construction of three more basins with annexes, to serve larger coasting, and even sea-going vessels. The third stage will comprise a further series of basins, the details of which remain to be settled. The entire project will involve the conversion of the existing South Basin into an entrance channel for the new basins on both sides.

The aggregate quayage in the zone of operations resulting from the execution of the works in the first instalment would amount to 2,476 metres (2,700 lin. yds.), being an increase of 50% on the present quayage length and sufficient to provide accommodation for the simultaneous berthage of 18 vessels. Construction would be in reinforced concrete, similar to the system adopted on the south bank of the Riachuelo.

An ancillary feature of the undertaking is the replacement of the Nicolas Avellaneda transporter bridge across the Riachuelo by a large new high-level lift bridge, which is actually in course of construction. The new bridge will serve both vehicular and pedestrian traffic between the cities of Buenos Ayres and Avellaneda, and will link up the inland road system with the approaches to the port extension.

**The Port of Memel and the Reich.**

The forcible occupation of the Port of Memel by Germany and the loss to Lithuania of its only seaport has naturally directed attention to the trade of the place. According to a recently-issued survey of the Reich statistical office, the sea-borne trade reached a figure of one and a half million tons in 1938. The most important commodity handled is, of course, timber, but coal, cement, fertilisers, oil and grain also appear in the trade returns. Certain changes in the turnover of goods are expected to occur in consequence of the transfer of nationality, and the further development of the sea-borne trade cannot be forecast with confidence. The shipping visiting the port is largely German, about one-third of the vessels flying the German flag.

Meanwhile, arrangements have been entered into by the Reich with the Government of Lithuania to provide another port for that country, together with certain privileges in regard to Customs regulations, at the Port of Memel. It was indicated in our Notes of the Month for March last that a port capable of accommodating overseas shipping was contemplated at Shventai, but whether this project is to be proceeded with is doubtful. Indeed, it is difficult to see the necessity for the expenditure of a large sum of money on a new port in such close proximity to Memel, especially if reasonably adequate facilities are afforded to Lithuania for the use of the latter. The matter may, however, be complicated by questions of national independence and prestige and, when this is the case, considerations of economy are apt to be relegated to the background.

**Rodent Extermination at Ports.**

The section of the recently-issued 1938 Annual Report of Dr. W. M. Fraser, Medical Officer of Health to the Port Health Authority of Liverpool, which deals particularly with measures taken against rodents is of special interest to all port officials, not merely on account of the menace of rats to the health of the community, but because of the damage done to foodstuffs and other commodities temporarily located on dock and riverside quays. As agents for the conveyance of plague, rats are well known and are justly to be dreaded, but they are equally an evil in their depredations among cargoes of an edible kind.

The measures taken at Liverpool to combat infestation of ships and quays are very thorough. A certificate, not more than six months' old, is required from incoming vessels, showing that an approved process of rat extermination has been carried out, or of exemption after a thorough inspection has revealed no evidence of the presence of rats. Then all vessels arriving from abroad are inspected by trained rat-searchers soon after arrival, and during the discharge of cargo; they examine not only for evidence of rat infestation, but search for dead rats which are forwarded to the City Bacteriologist. Live rats are also caught by a trained staff of rat-catchers, and these likewise are sent to the City Bacteriologist for examination. Rat harbourages are sought out on board ship and, with the co-operation of shipowners, or agents, are eliminated. Rat-guards placed on mooring ropes prevent the passage of rats from ship to shore.

As regards the quay sheds, the report states that the Liverpool docks are of solid construction and, generally speaking, present a minimum of rat harbourage. Certain places, such as engineers' stores, accessory structures of a temporary or semi-permanent character, etc., are liable to harbour rats, but, as a result of long-continued action, such premises have been made rat-proof, and by constant supervision are so maintained. As a result of all these measures, the risk of introduction of rat plague into the Port of Liverpool has been very greatly reduced.

This is evidenced by the fact that when the process of fumigation has been carried out by expert contractors under official supervision, the average number of rats per vessel discovered after fumigation has declined from 58.83 in 1924 to 1.67 in 1938, and the average number of mice from 2.27 in 1924 to .45 in 1938. During cargo discharge, prior to fumigation effected by sulphur dioxide, hydrogen cyanide or salforkase, the vessel is breasted off 6-ft. from the quayside, and rat-guards are fixed to all moorings, while a single gangway only is permitted, with a watchman in attendance, day and night. The gangway is lifted at sunset and not lowered till sunrise.

Only by such stringent regulations as these can ports hope to keep themselves free from the malignant menace of rodents, and Liverpool is to be complimented on the efficiency of its rat extermination service.

**West African Ports and the Ground Nut Trade.**

In the Monthly Circular for April-May, 1939, of the Baltic and International Maritime Conference is published a report of a delegation sent to Senegal by the Conference in the preceding February, in order to investigate the ground-nut trade, and particularly shipping and loading conditions for ground-nuts.

The Report, an extract from which appears on another page, contains much interesting and serviceable information about the ports of Senegal, the chief of which is Dakar, with some 17 others of less importance, either on the coastline, or located on rivers and estuaries. The Port of Dakar is accessible at any time, day or night, but the approaches to the others are somewhat difficult, partly because daylight is essential in order to anchor, and partly on account of tidal conditions in the rivers.

As regards Dakar, it would appear from a memorandum supplied by the Chief Engineer of the port that its location offers excellent possibilities of extending the present port facilities. There are no difficulties of a technical nature to prevent the Outer Roads being protected against swell. The depth of water in the roads is 15 metres (say 50-ft.), which is ample for the largest vessel likely to call, while Gorée Island forms a natural breakwater for the protection of the harbour. Various schemes are stated to be in hand for improving the port and its approaches. The depth of water in the Petroleum Basin and at the bunkering quays has been increased to enable vessels of 32-ft. draught to moor alongside at low water. Modern sheds covering 17,000 sq. metres are in course of erection, and it is contemplated to equip No. 2 Pier with four electric cranes of three to six tons capacity, having a working radius of 60-ft. A sum of 36 million francs has been allocated to the construction of a new basin capable of accommodating three large modern vessels for simultaneous handling at the quayside. Provision will be made for vessels up to 275 metres (900-ft.) in length, with a draught of 38-ft. This work is expected to be completed in 1941.

The programme is a striking one. It is clear that the French Colonial authorities envisage a considerable development of the local trade in the near future, and are taking steps accordingly.

# The Extension of the North Mole at Leixoes Harbour, Portugal

By DUARTE ABECASIS (I.S.T.), Engineer-in-Charge.



View of Entrance to Leixoes Harbour. Note high waves in background

## The Existing Breakwater

AS is generally known, the mole in course of construction for the protection of the entrance of Leixoes Harbour, was so seriously damaged during the storms of the winter 1934-35, that it could be considered as practically destroyed for its outer length of 120 metres.

Thus, once more, has been evidenced the tremendous exposure of this coast, undoubtedly one of the most dangerous in the world.

Since the structure maintained its contact with the rock bottom, the disaster could not be attributed to undermining, but only to the inadequacy of a wall 15 metres wide, or, at least, of its monolithic upper part, to withstand the impact of the partially broken waves which impinged against the mole.

Notwithstanding this, the commission of civil engineers and naval hydrographic engineers who inspected the work after the disaster, and studied the problem, were of opinion that, on account of the exposure of the work and the conditions of depth and sandy bottom met with in the outlying part, it was the adoption of the vertical type itself that was objectionable. In fact, the precautions necessary for the protection of the bottom would be so expensive that all the economical advantage of the vertical wall would be lost, leaving the stability of the work very doubtful, since, during violent storms, reflection of the waves would be rendered impossible by lack of depth, reduced as it would be by the protective apron. The attacking waves

by lowering this level. This consideration led me to a closer analysis of the purposes in view for the construction of the mole. They had been defined by a technical commission, of which the writer was a member in 1929, and were:—

- (1) To afford a protection to ships entering the harbour.
- (2) To improve the very poor condition of the inner shelter.
- (3) To avoid the considerable shoaling observed at the entrance.

The consideration that, for accomplishing such purposes, it would suffice to break storm waves and to absorb their residual

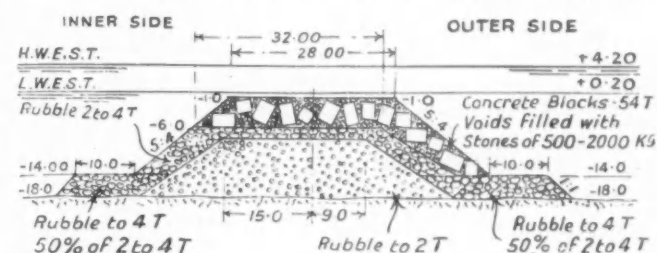


Fig. 2

energy by the interposition of a wide zone of deep water, resulted in the suggestion of the first type of mole proposed and represented in Fig. 1. It would be possible in this way, to economise £300,000, without failing to provide serviceable protection to ships entering the harbour and good shelter within the basin. As to the shoaling, it would be avoided by the intumescence produced by the waves in the water behind the mole.

The first suggestion would have been adopted were it not that constructional difficulties would arise, in consequence of the low level assigned to the top of the work, and the endward projection from land, and the difficulties in using a large floating crane in such dangerous waters.

I then resolved to lower still further the level of the crest of the work to the limit allowed by the fulfilment of the following condition, viz., to disperse waves high enough to endanger navigation, considerably reducing their height when crossing the mole without regard for the disturbance due to the movement of small waves, chiefly at high water spring tides.

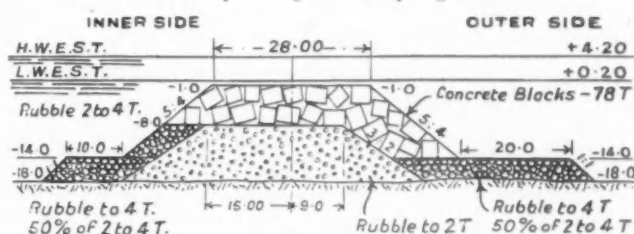


Fig. 3

To be precise, consideration was limited to the reduction of waves four metres to eight metres high, as, with higher waves, no ship would try to approach the coast.

As regards the shelter provided by the basin, there will be a very great improvement, even with the highest waves, as these will always be broken and greatly reduced in height and energy, when crossing the work.

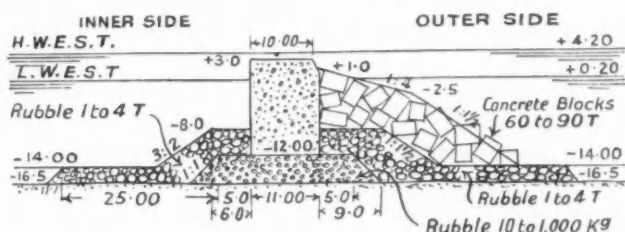


Fig. 1

would then assume a transitory character, breaking violently upon the work.

## Revision of Design

So the commission suggested the adoption of the mound type of mole, recommending the type of the principal mole of Casablanca Harbour. This suggestion was studied by a new commission, including Mr. W. F. Stanton, the local Chief Engineer of the Anglo-Dutch Engineering and Harbour Works Co., Limited, who submitted a new design for the work.

For an extension of 900 metres, the cost was estimated at nearly £1,370,000. Making a sufficient allowance for subsidence of the rubble mound through the sandy bottom; for an additional length of 100 metres desired by the naval authorities, and for the widening of the section to form the head of the mole, the cost of the work would be increased to nearly £1,770,000, while the cost of maintenance, estimated by the first commission at another sum, equal to the cost in 50 years, would represent a yearly charge of £35,400.

The very high cost of the work led the high authorities to recommend to the technical services, under the superintendence of the writer, the consideration of possible reductions.

As the cost of any work of this kind increases very rapidly with the height of its crest, a reduction could only be obtained

*Extension of North Mole, Leixoes Harbour, Portugal—continued*

The type of work adopted was suggested by an experience of the effects of works, or parts of works, consisting of rubble or block mounds, merely reaching the level of low water, or a little lower. Their stability, when properly designed, is very satisfactory, thereby avoiding the heavy charges consequent upon damages suffered by works more definitely emergent, whether they be vertical walls or substantial and well-designed works of the mound type.

Besides, the effects of the mound in reducing the height of waves are very pronounced, on account of the great interference with the ordinary movement of the liquid particles.

If, as in the present case, behind the submerged mole there is found a large body of deep water, a great part of energy of the waves that cross the work will be absorbed therein, with corresponding reduction in height and force of impact.

**Experimental Investigation**

In spite of the guarantee provided by the circumstance that the type of work in view could very easily be realised in a cross-section of a mole of the Casablanca type, yet in case it should be found inadequate, and the circumstance that the work so designed, in a properly arranged constructional programme, must be the first element to be built, it was deemed advisable to make experiments with reduced scale models.

The results of these studies, made under the direction of Professor Stucky at the laboratories of the School of Engineers at Lausanne University, were perfectly satisfactory as regards stability, and may be considered as very satisfactory also as regards the protection provided by the work, if all the local conditions are taken into account.

In fact, it is unimportant if small waves traverse the work, at high tide, without any great reduction, or if behind the mole are still in evidence storm waves so high that no ship dare approach the coast. The important point is the provision of favourable conditions for entering the harbour at normal times and during high wind. As to the conditions of shelter at the harbour, these will in every case be greatly improved.

Obviously, the best protective effects are obtained with the lowest level of tide.

On the contrary, the severest conditions for stability are those obtained if a gale occurs at high water.

Fig. 2 represents the first type studied. In Fig. 3 may be seen the first alterations introduced:—

- (1) An increase in the weight of the blocks from 54 to 78 tons.
- (2) Suppression of the filling with rubble of the voids between concrete blocks.
- (3) Widening of the outer berm.

In experiments, depths of -12.00 metres and -18.00 metres to be met with at the extremities of the work to be built, were considered.



Situation in 1936 after the placing of 90-ton concrete blocks, at random, as protective covering



Vertical wall of new Mole in process of construction—seen from the head of Northern Mole, 2nd October, 1934

For high water the level of +4.20 metres was taken, and for low water zero (0.00 metres).

The waves experimented with had lengths of between 100 metres and 220 metres. The heights varied between 3.10 metres and 10.00 metres.

For depths of -18.00, during high water, it was found that small waves cross the work without breaking, and maintain nearly the same height.

Waves 4.00 metres high, with a length of 100 metres, break slightly and lose part of their energy. Waves, six metres high and 120 metres long, break distinctly, losing most of their energy and being greatly reduced in height behind the mole. A slight oscillation was imparted to the top layer of rubble of half to two tons weight. Waves, nine metres high and 220 metres long, break violently upon the work, being destroyed for the greater part. Nevertheless, the 54-ton concrete blocks were not disturbed.

The conditions for low water were then tested. Waves, four metres high and 100 metres long, broke upon the work and were practically destroyed.

On the outer side of the mole was observed a partial reflection, due to the steepness of the slope, something like a "clapotis" (reflected wave).

The crossing of the work by waves six metres high and 120 metres long, presented the appearance of an overflowing rather than a proper breaking. The work was much disturbed in its upper part by horizontal currents on both sea and harbour sides, the light stones being drawn away, leaving the concrete blocks exposed. With waves 9 to 10 metres high and 220 metres long, there was an important overflowing with a sensible commotion continuing past the work in its neighbourhood. There was still observed a kind of "clapotis" in front of the mole.

Some of the concrete blocks were thrown to either side of the work, without affecting very appreciably the outline of the cross-section.

For the depths of -12.00 metres, the trials started with high-water conditions. Waves, four metres high and 100 metres long, were much deformed and partially broken.

For heights of six metres and lengths of 120 metres, waves that reached the work much deformed broke at the middle of the crest and were practically dispersed, the movements on the harbour side being strongly reduced. There was noted only a slight oscillation of the small elements at the top of the work.

Waves of 9.40 metres, with a length of 220 metres, reached the mole completely deformed, breaking violently upon it and being nearly totally destroyed. The work was not damaged by their action.

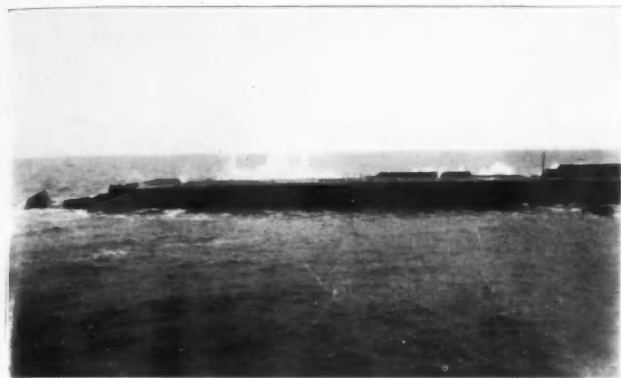
The trials in low water started with 4.00 metres waves, 100 metres long, which were completely broken and slightly moved the light stones of the filling between the blocks.

For the height of 6.00 metres and length of 120 metres, the waters broke upon the crest, creating strong cross currents,

*Extension of North Mole, Leixoes Harbour, Portugal—continued*

causing suction on the sea side of some of the concrete blocks, but without disorganising the section or affecting the berms.

Waves, 8.00 metres high and 220 metres long, broke partially before they reached the work, completed their breaking upon it, and still transmitted part of their energy to the mass of water on the other side. Movements of blocks on either side were observed; also a slight flattening of the corner and slope of the outer rubble berm.



First stage of storm damage to Mole, 22nd December, 1934

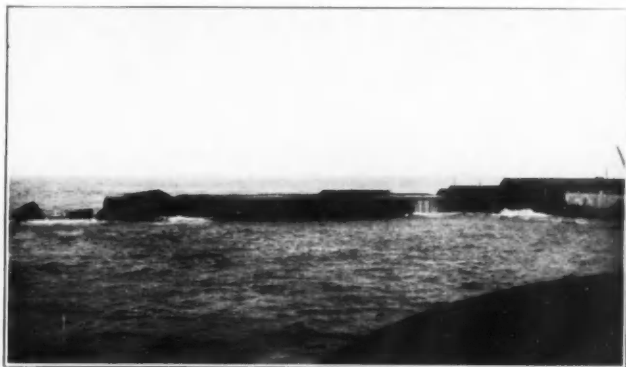
These trials were made in a channel with a width of the same extent as the length of the mole. The waves approached the work at right angles to its longitudinal axis.

The reflections of the waves behind the work, against the top wall of the tank, were avoided by finishing it with an inclined plane.

The results of this and other series of trials led to the adoption of a cross-section, which was finally considered satisfactory, and is represented in Figs. 4, 5 and 6 (shown on the Supplement).

The changes introduced were:—

- (1) An increase in the weight of concrete blocks to 78 tons (subsequently further increased to 90 tons).
- (2) As a result of the increase in the dimensions of the blocks, the top level of rubble mound was lowered to -8.00 metres.
- (3) Flattening of surface slope of protection blocks to 2 : 1 on the outer side, and to 3 : 2 on the inner side.
- (4) Extension of inner protection in concrete blocks to the level of the inner berm, which remains at -10.00 metres.
- (5) Widening of rubble mound top, at the level of -8.00 metres from 24 to 30 metres, in order to prevent the flattening of slopes, resulting in a great increase of the number of concrete blocks to be used.
- (6) Widening for the lesser depths of the outer berm, so so that it varies between 20 metres for depths of -12.00 metres, and 12 metres for depths of -16.00 metres and deeper.
- (7) Lowering to -10.00 metres of the level of the outer berm, for depths of -12.00 metres. The rubble apron will keep the thickness of 2.00 metres as far as the depth of -16.00 metres. Farther out, the level of the berm will be maintained at -14.00 metres, and the width at 12 metres.



Extension of damage to Mole, 4th January, 1935

Another series of tests was made to investigate the stability and protective effects of this type of mole, using not only the channel-tank but also a wide trough, in which the complete mole was reproduced.

The tests in three dimensions, made with the wide trough, gave an idea of the relative importance of the damage observed in the experiments in two dimensions (channel-tank), and the possibility of examining certain details, such as the erosive effect of waves when passing the head of the mole.

As to the protective effect of the work, the tests gave the following results:—

**TWO DIMENSIONAL TESTS**

Number of experiment	Average sea level	Length of waves in open sea = 2L	Height of waves in open sea = 2h	L/h	Height of waves on harbour side — 200 metres behind the mole	Reduction Factor
611	m.	m.	m.		m.	
612		107	4.20	25.5	3.55	0.85
613		107	6.55	16.3	4.65	0.70
	+ 5.20	148	6.35	23.3	4.90	0.77
614		168	8.55	19.7	5.45	0.64
615		231	9.60	24.1	7.15	0.75
616		238	11.90	20.0	9.50	0.80
653		102	4.20	24.3	3.30	0.78
654		102	6.60	15.5	3.90	0.60
655		150	7.05	21.3	4.75	0.67
656	+ 4.20	142	8.55	16.6	5.30	0.62
657		231	9.50	24.3	5.75	0.60
658		242	14.00	17.0	9.65	0.69
617		109	5.45	20.0	3.70	0.68
618		110	7.00	15.7	4.00	0.57
619		144	6.15	23.4	4.55	0.74
620	+ 3.20	144	8.55	16.8	4.75	0.56
621		231	9.65	23.9	7.00	0.72
622		238	11.30	21.0	7.75	0.69
623		107	4.95	21.6	2.75	0.55
624		109	5.50	20.0	3.00	0.55
625		144	6.85	21.0	3.15	0.46
626	+ 1.10	150	10.00	15.0	4.95	0.50
627		203	11.90	17.0	5.90	0.50
628		238	12.20	19.5	6.65	0.55
659		102	4.40	23.2	1.75	0.40
660		105	6.15	17.1	2.25	0.36
661	+ 0.20	147	6.35	23.1	3.00	0.47
662		147	9.60	15.3	4.15	0.43
663		210	10.35	20.2	4.70	0.45
664		220	12.70	17.3	6.10	0.48
665		210	10.60	19.8	4.20	0.40

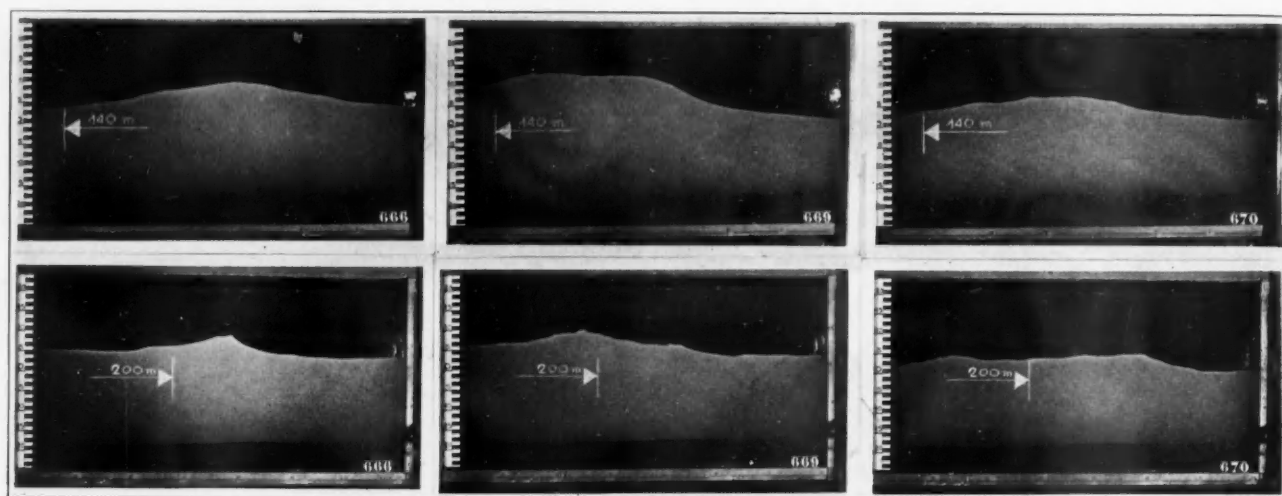
Measurements of the height of the waves were taken in the channel-tank by electrodes, the conductivity of which varied according to the degree of immersion, placed, one on the outer side of the mole and the other on the harbour side, 200 metres distant from the axis of the work.

The electrodes are connected to oscillographs, the indications of which were marked on sensitive paper, so that, in this way, was kept a register of the oscillations of water level.

Curves of rating, previously drawn, gave the correction for effects of inertia.

**THREE DIMENSIONAL TESTS**

Number of experiment	Average level in open sea	Length of waves in open sea	Average height of waves in sea			Reduction Factor	
			At A	At B	At C	At B	At C
629	m.	m.	m.	m.	m.		
630		100	6.15	4.65	5.25	0.79	0.85
631		100	8.25	4.80	6.15	0.58	0.75
	+ 5.20	140	7.35	5.55	5.70	0.76	0.78
632		140	9.75	5.70	5.70	0.58	0.58
633		220	9.60	8.10	7.50	0.84	0.78
634		220	9.75	7.35	7.20	0.75	0.74
641		100	4.95	4.20	4.35	0.85	0.88
642		100	6.60	6.15	4.95	0.93	0.75
643		140	6.00	4.95	5.25	0.83	0.88
644	+ 4.20	140	7.95	5.25	5.10	0.66	0.64
645		220	9.60	6.90	6.60	0.72	0.69
646		220	12.75	8.10	8.25	0.64	0.65
635		100	4.80	3.60	3.60	0.75	0.75
636		100	6.90	3.30	3.15	0.48	0.46
637		140	6.45	3.90	3.15	0.60	0.49
638	+ 1.10	140	7.20	4.05	4.05	0.56	0.56
639		220	11.10	5.10	4.95	0.46	0.45
640		220	8.70	7.20	5.40	0.93	0.62
647		100	5.10	3.30	2.70	0.65	0.53
648		100	9.15	3.90	3.30	0.43	0.36
649		140	9.15	4.35	4.20	0.48	0.46
650	+ 0.20	140	10.50	4.80	4.65	0.46	0.44

*Extension of North Mole, Leixoes Harbour, Portugal—continued*

Test 666.  $2L=140$  m.  
Range at Sea  $2h=6.50$  m.  
Mean Sea Level  $+5.20$  m.

Top Row.  
Test 669.  $2L=220$  m.  
Range at Sea  $2h=12.00$  m.  
Mean Sea Level  $+5.20$  m.

Test 670.  $2L=140$  m.  
Range at Sea  $2h=7.00$  m.  
Mean Sea Level  $+3.20$  m.

Range in Port  $2h=5.50$  m.  
Reduction Factor 0.85

Bottom Row.  
Range in Port  $2h=7.00$  m.  
Reduction Factor 0.58

Range in Port  $2h=4.50$  m.  
Reduction Factor 0.64

In these experiments there were three electrodes, the first "A" on outer side of the mole, the two others being parallel to the axis of the mole, 200 metres from the harbour side; one "B" in front of the head, and the other "C" 300 metres from the side of the entrance to the harbour.

The results obtained are shown in Fig. 7, where reduction factors are represented as ordinates and heights of the waves as abscissae. For tracing the curves, only the waves with lengths between 19 and 24 times the heights were used.

Values relative to waves with  $\frac{L}{h}$  smaller than 19 are represented individually by a small circle for two dimensional tests and by a small square for three dimensional tests.

It is evident from the graphs that, especially for high tide—the most interesting condition—the larger the factor, the smaller the reduction, for small amplitudes.

The reduction increases (or the factor decreases) with increases in the amplitude of the waves, the curves making a minimum, corresponding to a maximum of reduction, for amplitudes between 8.00 metres and 9.00 metres, precisely the most important in the question of entrance conditions for navigation into the harbour.

It is shown also by the graphs, very clearly, that the smaller the values of  $\frac{L}{h}$ , that is to say, the shorter the waves, the larger is the reduction. The longer waves are, then, less affected by the work.

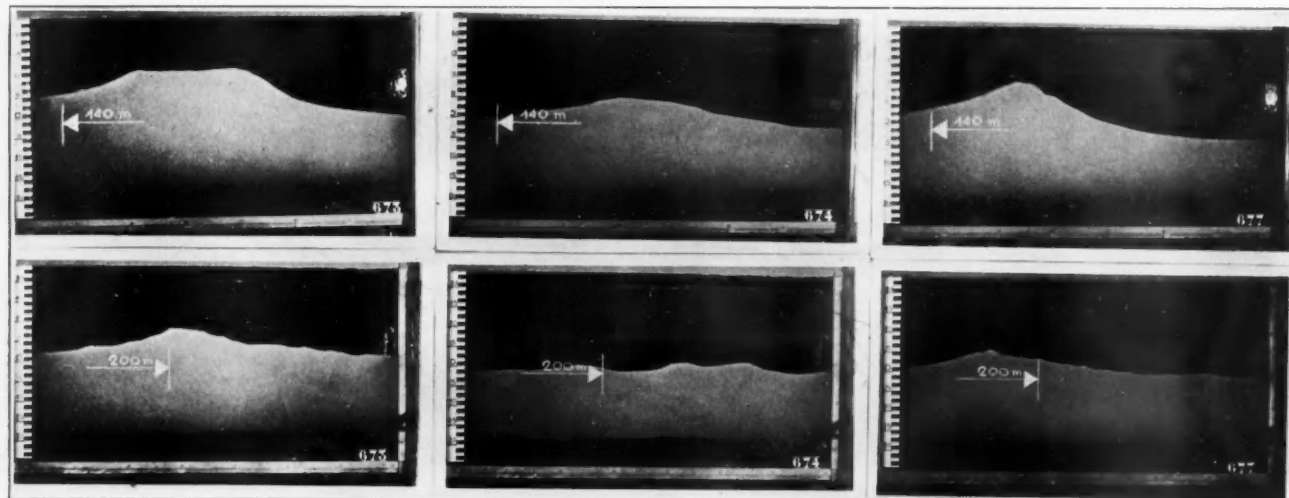
The photographs presented give an idea of the reductions obtained for various circumstances of tide, and amplitude and length of waves.

From these experiments, Professor Stucky concludes:—

- That for H.W. of  $+5.20$  metres the amplitude of oscillations in the track of navigation is generally between 60% and 85% of the amplitude at sea, according with absolute and relative values of  $2h$  and  $2L$  at sea.
- At L.W. of  $+1.10$  metres, the amplitude of oscillations in the track of navigation varies between 45% and 60% of amplitude at sea, according with absolute and relative values of  $2h$  and  $2L$ .
- For the same length  $2L$ , the reduction of amplitude is greater for higher waves. The longer waves are the most dangerous for same amplitude.

As to the stability, the final tests were particularly severe, not only as regards the amplitude of the waves, but also the duration of storm. In fact, as the highest waves that are considered as possible at Leixoes were not able to affect the work, even after a long period of attack, it was resolved to increase the amplitude beyond all possibility, in order to ascertain the height of the waves which would sensibly affect the work.

As to the duration of the storm, it was maintained for twelve hours for each position of the average level of water that was



Test 673.  $2L=220$  m.  
Range at Sea  $2h=12.50$  m.  
Mean Sea Level  $+3.20$  m.

Top Row.  
Test 674.  $2L=140$  m.  
Range at Sea  $2h=7.50$  m.  
Mean Sea Level  $+0.20$  m.

Test 677.  $2L=220$  m.  
Range at Sea  $2h=14.50$  m.  
Mean Sea Level  $+0.20$  m.

Range in Port  $2h=7.00$  m.  
Reduction Factor 0.56

Bottom Row.  
Range in Port  $2h=3.20$  m.  
Reduction Factor 0.40

Range in Port  $2h=7.00$  m.  
Reduction Factor 0.48

### Extension of North Mole, Leixoes Harbour, Portugal—continued

tried, even for the level of +0.20 metres, which, being the most unfavourable from the point of view of stability, will never be experienced during a great storm, as we will explain.

The following were the results obtained:—

#### Mole in Deep Water – 18.00 Metres.

In a general way, the work was not affected by the storm, the best degree of stability corresponding to the highest level of the sea.

With the average level of water at +5.20 metres, and after 12 hours of continuous incidence, the waves of six metres and those of nine metres, long or short, did not affect the work at all.

With the average level of the water at +3.20 metres, and after 12 hours of continuous incidence, the waves of 6.00 metres and those of 9.00 metres, long or short, did not affect the work in the slightest degree.

The continuous incidence, during 12 hours, of waves 12 metres high and 220 metres long, exceeding by three metres the maximum height admissible, resulted in a settlement of the concrete blocks protection and in a flattening of the slopes, without affecting the remaining elements of the structure.

With the average level of the water at +0.20 metres, maintained during 12 hours, which is doubly impossible: as to the level of low water, which in heavy storms is invariably raised by the accumulation of the water against the shore; and as to the duration of low water by more than six times the normal period; it was seen that the waves of 6.00 metres and those of 9.00 metres, and short length, did not in the least affect the work. Waves of 9.00 metres and greater length, still under these conditions of duration, only caused local movements, due to fortuitous circumstances, such as the removal of some block which had fallen during the construction into an unstable position, without affecting sensibly the whole of the work.

The waves, 12.00 metres high and 220 metres long, resulted, by their prolonged incidence, in the flattening of the slopes of the protective work, the settlement of blocks and the carrying to the inner side of a number of the blocks of the upper layer of the crest.

But it must be observed that the unfavourable limits of natural conditions were exceeded: by three metres as to the height of the waves; by six times as to the possible duration of a low water; by 0.60 as to the lowest level of water to be considered during an exceptional gale.

#### Mole in Depths of – 12.00 Metres.

Similar results were observed.

With the average level at +5.20 metres, the waves, 12.00 metres high and 220 metres long, acting 12 hours uninterruptedly, did not affect the work.

With the average level at +3.20 metres only, the waves, 12 metres high, acting for 12 continuous hours, displaced a reduced number of blocks, without affecting sensibly the outline of the section.

With the average level at +0.20 metres, neither the short nor the long waves of 9.00 metres length, acting for 12 hours, originated the slightest displacement. Only waves 12.00 high, while not affecting the outer slope neither the outer part of the crest, originated the carrying away of some blocks of inner part of top layer, resulting in a flattening of inner slope of protection blocks.

In face of these results, the following questions arise:—

What would have happened to the vertical wall as first designed, even with the bottom protection strongly reinforced?; and what would have happened to any work of the mound type, as at Casablanca, if exposed to the long assault of such formidable agencies?

Notwithstanding such satisfying results, we increased still, in the final design, the weight of the protection blocks, from 78 tons to 90 tons.

Turning to the protection provided by the mole, let us examine now, to close this study, in the light of practical conditions and local circumstances, what will occur during a very severe gale, as one with long waves eight metres high.

Let us take a tide between a low water of +1.10 metres and a high water of +4.20 metres, which may be considered as reasonable, if we note that during the 10 years ended at 1935, the highest high water registered at Leixoes was +4.48 metres.

We may conclude from the tests that, during high water, the level of which will practically continue for one hour, waves behind the outer part of mole will not reach more than five metres. After two hours, with tide at +3.20 metres, the height of waves will reach only 4.50 metres, increasing the reduction with the lowering of the tide. At low water, there will be waves with 3.50 metres to 4.20 metres.

A very important remark must, however, be made; both measurements of reduced waves were taken, in the three dimensional model, at points corresponding to outer depths of – 18.00

metres: one behind the head of mole; another 300 metres to the harbour side. But, over the 1,000 metres of mole, the remaining 700 metres correspond to outer depths of – 16.00 metres to – 12.00 metres. And with these outer depths, the energy of waves near the mole is sensibly smaller than for depths of – 18.00 metres, on account of its dissipation and on account of the shallower bottom.

That is the reason why, for depths of – 12.00 metres and high-water level of +5.20 metres, there has been observed in the tests a reduction to 5.20 metres of outer waves of 10 metres high, whereas, for depths of – 18.00 metres and the same external waves, the height of reduced waves reaches 7.50 metres to 8.00 metres.

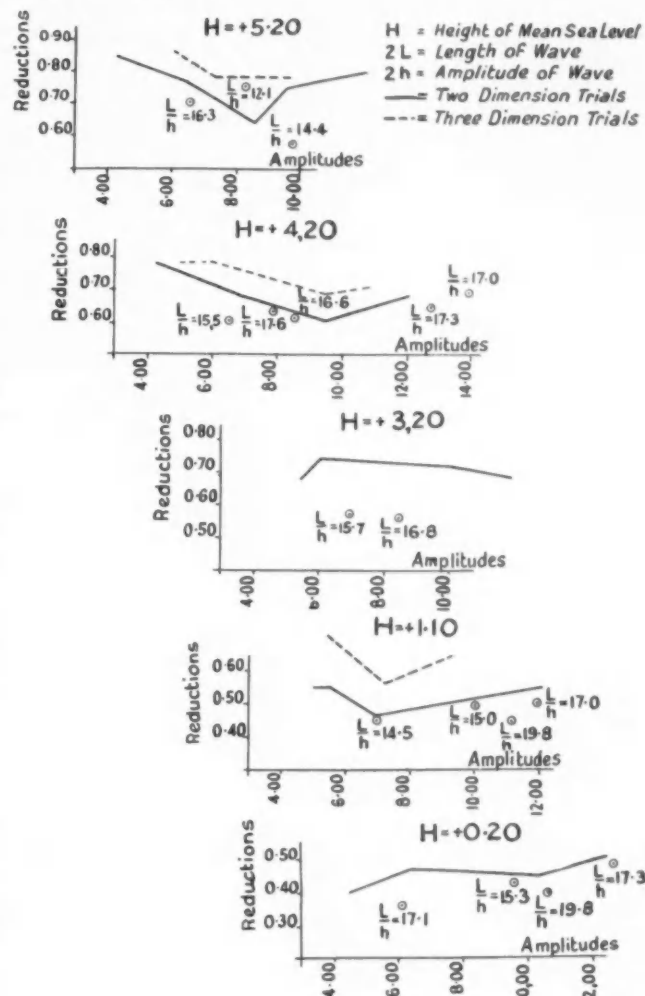


Fig. 7

So it is seen that for waves 10 metres high and depths of – 12.00 metres, the factor of reduction is smaller by nearly 1/3 than for depths of – 18.00 metres.

As all values included in the tables presented were taken from experiments with depths of – 18.00 metres, it is seen that for the higher waves, the said values lead to pessimistic results if applied to the inner two-thirds of length of mole. That is to say: when nearing entrance of the harbour and past the outer half of mole, ships will, during the storm under consideration, meet waves not higher than 3.40 metres at high water; 3.00 metres at two hours after it, and 2.40 to 2.80 metres at low water.

Ingress to the harbour will then be considerably eased, and conditions of inner shelter considerably improved, even during the most severe gales.

#### Estimate of Cost

Finally, reference will be made to the cost of work and its maintenance.

The estimate, considering a total length of 1,000 metres, and including the widening at the head of mole; an allowance for the sinking of the rubble mound through the bottom, assumed as 10% of its height; an allowance for unexpected contingencies, and all that has already been spent on the damaged work and its repair, reached £880,000.

Maintenance charge is estimated, according with results of trials, at no more than £2,800 a year.

Comparison of these sums with those of, respectively, £1,770,000 and £35,400, presented above, give an idea of the economy resulting from the new type of work.

# Shoreham Harbour

## Description of an Ancient and Still Flourishing Port

By HAROLD BROWN, J.P., Chairman of the Shoreham Harbour Trustees\*

### Ancient History

**S**HOREHAM HARBOUR is very ancient and dates back to the time when the Romans occupied Britain. At that period the entrance was simply a broad estuary stretching roughly from Shoreham to Lancing, with a channel made by the River Adur leading up to Bramber and Steyning, which was, as far as history tells us, the Portus Adurni of the Romans.

That ships used to go up the river there is no doubt, as, early in the last century, a ship's anchor was ploughed up in that fold of the hills on the right of the road from Shoreham to Steyning just beyond the Beeding Cement Works, which is known to-day as Anchor Bottom, and was no doubt in early times a creek of the estuary where vessels could shelter.



[Block by Courtesy of Messrs. E. J. Burrow & Co., Ltd., Cheltenham]  
Shoreham Harbour, showing nearly two miles of locked water, looking east from Southwick to Hove

### Formation of the Spit

Some years later, a large bank of shingle commenced to accumulate from the westward, and a spit grew out from the mainland at Lancing, gradually travelling eastward. As soon as the estuary became protected from the sea by this bank of shingle an accumulation of mud and sand took place on the sheltered area by silt being deposited, and the bottom was gradually raised until it became saltings and vegetation commenced to grow on it. This was the work of centuries. Doubtless, landowners reclaimed as much as possible by constructing earth banks confining the river, and the upper reaches also gradually silted up, preventing the larger vessels getting up to Bramber and Steyning, and the sheltered water at Shoreham became the harbour.

This, as far as can be ascertained, was then situated where the Old Swiss Gardens lake still is, and probably ran inland a short distance in a north-easterly direction, because only last year when the ground thereabouts, which is still below river level, was being excavated in connection with an extension of the Council School, a formation of wooden piles was found several feet under ground level, which was presumably some sort of wharf or jetty for vessels to lie against.

The spit of shingle referred to continued to form, and spreading eastward gradually forced the river mouth in that direction, until in about 1759 the river ran into the sea at the Wish, Aldrington. The harbour, therefore, had been extended from Shoreham to Portslade, being protected from the sea by the large bank of shingle which at that period was probably much in the same condition as we have known it in our lifetime except that then there were no buildings on it.

In 1760 a cut was made through this bank of shingle somewhere about where the present entrance is, and two timber piers

were built to form a harbour entrance, but in 1763 the timber piers were destroyed by storm, and the river mouth was gradually forced eastward again until 1815, when it was nearly in the same position as in 1760. In 1815, a fresh entrance was cut at Kingston, where the present entrance now is, and has been maintained ever since, with varying fortune as regards damage by storms.

The making of the entrance at Kingston converted the harbour into two arms, the Western Arm running up the river through Shoreham to the country beyond, the Eastern Arm being the old channel of the river as far as the old mouth at Aldrington. I gather that the old mouth was never artificially blocked up, but that owing to the drift of shingle it was quickly filled up by the sea as soon as the scour from the outgoing river ceased.

It is interesting to note here that the action of the sea, which, centuries ago, caused this drift of shingle to accumulate right across the estuary, during the last century or two caused erosion to take place along the coast in this neighbourhood, no doubt owing to supplies further to the westward becoming exhausted, necessitating heavy groyning to be carried out along the coast to the westward. When I became a member of the Shoreham Harbour Trust, and for some years previously, it was a matter of necessity continually to dredge the entrance of the harbour to keep it clear of shingle and to prevent a bar forming. In fact, for some years there was a bar right across the entrance, and some interested parties arranged a cricket match to be played on it so as to draw public attention to the condition of affairs. This was eventually cleared, and some 80,000 to 90,000 tons of shingle were lifted annually. Most of this was dumped to the eastward of the harbour to maintain the beach on that side. Of late years, owing to the effective groyning of the westward coast, the shingle has been retained, and the drift has more or less ceased—at all events, the Trustees have had to do little or no dredging at the entrance.

No doubt as soon as the harbour entrance was completed, wharves and jetties for the convenience of traders were built, but I have no information as to which was the first, or when any were built.



[Photograph by Thomas, Kingston-by-Sea]  
The Free Wharf

In 1852-1855 the canal and Aldrington Basin were artificially constructed by excavating partly along the old course of the river, and by building the present south bank of the canal and constructing the old lock so as to have a floating dock where vessels could always lie afloat. This was of enormous benefit to Brighton traders, and has in no small way been responsible for the eventual success of the present-day harbour undertaking.

### Harbour Administration

At this time the harbour was controlled by Commissioners who were appointed under the Harbour Act of 1760, the capital being provided by shareholders, and these continued in control until 1873, when a new Act was obtained transferring the powers to Trustees and also giving them powers to raise a considerable sum for harbour improvements. The harbour piers were lengthened and various other improvements made, the money being obtained by the issue of debentures, the mortgagees being given "A" debentures, the original shareholders only getting their shares transferred to "B" debentures, which did not rank for interest until all interest on "A" debentures had been

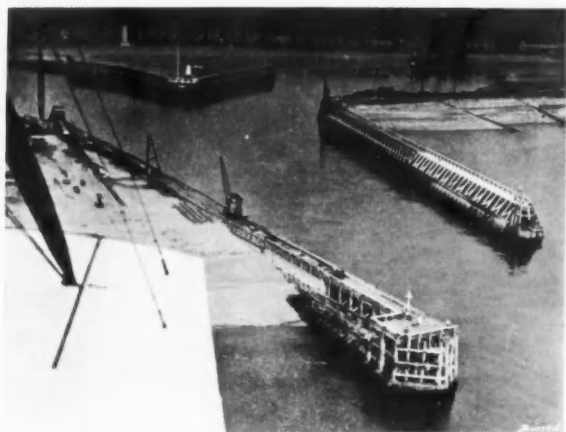
\* Address delivered to the Brighton Rotary Club on 1st Feb., 1939.

*Shoreham Harbour—continued*

paid. However, for many years both received their interest, "A" shares at 4½% and the "B" at 4%.

This part of the harbour has also experienced vicissitudes—in April, 1907, the walls of the lock partly collapsed without warning, and for some little time caused much confusion and delay to shipping and also very heavy expense to the Trustees, as it cost about £11,000 to reinstate the lock. The borrowing powers of the undertaking having been exhausted, this money was found by the "A" debenture holders, and from that date the "B" debenture holders received no interest. The proper maintenance of the harbour was carried on with great difficulty, the revenue being barely sufficient to meet the maintenance charges and the "A" debenture interest.

During the War trade to the harbour practically ceased, and with very little revenue accruing, the financial position became very acute. With no funds coming in and no reserve to fall back on, proper maintenance of the harbour in connection with the piers, wharves, channels, etc., fell into such arrears that the Trustees were forced to apply to the Board of Trade for powers to increase the rate of dues, and in 1918 the Board made an Order authorising the Trustees to increase the dues by 100% above the basic rate allowed under previous Acts.



[Copyright photograph by the Collingwood Studios, Shoreham-on-Sea]  
Shoreham Harbour Entrance

In the meantime, it was realised by the Trustees that if they were to pull the harbour through and make it a successful undertaking, they must have powers to borrow money and security to offer to enable them to do so, and it was decided to approach the local authorities interested, Brighton, Hove, Portslade, Southwick, Shoreham and Worthing, to back the Harbour undertaking by guaranteeing the interest both to the present mortgagees and for any future loans that might be necessary. At the same time, the mortgagees were approached with the view of writing down the amounts of their mortgages provided the local authorities guaranteed their interest—in other words, converting their holdings into gilt-edged securities.

After long negotiations, the Trustees were successful in both negotiations. All the local authorities, with the exception of Worthing, agreed to guarantee the interest, and the mortgagees' holdings were written down, "A" debentures from £81,800 to £63,804, and "B" from £29,300 to £8,350, and this was secured by Parliamentary Statute under the Shoreham Harbour Act, 1926, which also gave permanent powers to increase the dues up to 80% above basic rate, to create a sinking fund for the redemption of loans, and to create a reserve fund for contingencies.

The local authorities have never been called upon to contribute a penny to the harbour finances, nor does it now appear likely they ever will. From the time of the passing of the 1926 Act the affairs of the harbour have prospered exceedingly. Not only have all arrears of maintenance been made good, but the sinking funds now amount to £39,569 and the reserve fund to £15,962. Notwithstanding these accumulations, the dues have been reduced from 80% above basic rate to 30% below, and the piers, wharves, channels, etc., have been put into a satisfactory state.

In 1930 a new Act was obtained, giving powers to construct a new lock owing to the old one not being of sufficient size to accommodate the increased size of vessels now using the harbour, the old lock being converted into a dry dock where vessels can lie out of water and be examined all over, and have such repairs done to their hulls as may be necessary.

**Shipbuilding Industry**

There are no statistics at all available as to what the trade was in ancient times or in the Middle Ages, but in the last two centuries and during the time of wooden sailing vessels, one of the staple industries of the harbour was the building of ships. No doubt this was because there was a plentiful supply of Sussex

oak. Many were built at Shoreham, there being a fleet of over 500 registered at this port during the middle of the last century. These mainly consisted of brigs and barques of 300 to 500 tons burthen, and were noted all over the world where they traded for their staunch construction and good sailing qualities. But as iron and steel construction superseded timber, the trade naturally drifted to those places where that material was available. The last sailing trader built at Shoreham was about 65 years ago. There is no doubt that small war vessels were built at Shoreham, as history tells us that Shoreham provided more ships of war for Government purposes than many of the larger ports.

In order to give some idea of the increase of trade to the harbour, the following figures show that in 1888 the imports of coal were 100,000 tons; in 1938 they were 490,000 tons; fifty years ago there were no imports of oil or petrol; now there are six depots established in the harbour, and their imports last year were 100,000 tons. There are, of course, a considerable number of other goods imported, such as timber, bricks, cement and other building materials, which vary according to trade fluctuations.

For some years the railway passenger service between France and England came to Shoreham. Passengers were landed at Kingston Wharf, the boat train to London being boarded at a platform behind the Kingston Inn, but the Railway Company acquired Newhaven Harbour and transferred the service there in 1859, and the little station at Kingston was eventually closed.

*Dock Extension Work at Avonmouth*

Advance constructional details are now available in connection with the extension to the Eastern Arm of the Royal Edward Dock and the provision of additional facilities at the Oil Basin at Avonmouth, upon which work has just begun.

The scheme is being carried out for the Port of Bristol Authority under the direction of Mr. W. P. Wordsworth, Assoc. M.Inst. C.E., the Docks Engineer, at a cost of approximately £643,000.

It comprises an extension of 1,100-ft. long, 400-ft. wide and 32-ft. below normal dock level, to give an increased water area of 10 acres; provision of a combined transit and grain storage building, which will be connected to the existing grain-conveying system; reconstruction and setting back of the existing railway sidings; two new deep-water berths, with a new steam supply station, at the Oil Basin of the Royal Edward Dock, and the installation of sundry cranes, machinery and other equipment.

The extension of the Eastern Arm will provide four new berths, each of 550 lin. ft., but, as the quays will be constructed in an unbroken line, accommodation will be available for a greater number of vessels of smaller tonnage.

The wharves will be of reinforced concrete construction, similar to those in the existing arm, and will consist of a series of frames with the front and back curtain walls supported on reinforced concrete piles. More than 2,000 reinforced concrete piles will be made and driven for the work and, in addition, the new transit shed, also in concrete, will be erected on a piled foundation.

The contractors for the first stage of the work are Messrs. Chas. Brand and Son, Limited, of London, who will be engaged for approximately two years on the scheme. Part of their task will be the excavation of half-a-million tons of material, construction of reinforced concrete wharves on both sides of the extension, and two new timber jetties.

The contractors for the additional facilities at the Oil Basin, Royal Edward Dock, are Messrs. Christiani and Nielsen, Limited, of London, and this work has also been commenced.

The extension to the Eastern Arm of the Royal Edward Dock has become necessary as a result of the increased demand in recent years for sites adjacent to deep-water berths where lessees can discharge cargoes by their own machinery and directly into their own premises—this applies particularly to the milling industry.

Furthermore, the number of occasions are increasing when all available berths have been occupied. This is no doubt due to the consideration that East Coast ports may suffer in the event of an outbreak of hostilities.

Provision is also made in the scheme for the formation of a new sea bank between Holesmouth Rhine and Michell's Gout. This is designed primarily to protect land which may be leased at a later date, and will necessitate a re-arrangement of the existing sidings at Holesmouth.

The last extension at Avonmouth was carried out in 1924-1928, and the need for the present work is emphasised in the official figures, showing a comparison between the traffic handled in 1933 and 1938, as at the 31st March each year. In 1933, the number of vessels docking at Avonmouth was 3,046, and the goods handled amounted to 2,199,446 tons. By 1938 this had increased to 4,236 vessels and 2,787,793 tons.

## Dredging Research in France

**Contribution à l'étude du Dragage et du Refoulement des Déblais à l'état de mixtures.** (Contribution to the study of dredging and pumping of spoil in a liquefied state), by P. Durepaire, Ing. des Ponts et Chaussées, in "Annales des Ponts et Chaussées," 1939; Vol. i., Part II (February).

This is a very important paper dealing with the improvement in the output of plant for the pumping of dredged spoil. The Author points out that, in many cases, highly efficient engines are coupled to centrifugal pumps of a pattern which has undergone no change for some 30 years. This type of pump is made with a shroudless impeller, with three, four or five blades, mounted on ribbed arms springing from the hub; the effective part of the blades, generally immovable, has a uniform breadth equal to the distance from the back liner to the entrance opening; the pump chamber is of a plain rectangular section, with a width equal to, or slightly exceeding, that of the impeller.

The simplicity and absence of obstruction in this type of pump account for its retention but, in countries other than France, important improvements have already been made. There is a wide scope for such improvements, and without them some jobs cannot be tackled at all.

The problem of improved pumping affected the engineers engaged in the regulation of the Loire at Nantes and in the filling of dredged material into the old river beds there.

The reclamation work amounted to more than 2,000,000 cubic metres in volume, and the distance from pump to dump extended up to 1,700 metres. They had a 650 h.p. pipe line dredger capable of pumping 450 cubic metres to a distance of 500 metres in over an hour, and a 1,000-h.p. barge unloading plant, driving by belts two of the classic Dutch-type pumps in series, discharging through a 580 mm. pipe line. The latter would pump, in 15 to 20 minutes, 230 cubic metres of sand, barge measure, to a distance of 400 to 500 metres. It, however, proved impossible to force the spoil beyond 900 metres without the pipe becoming blocked, and at this distance the pumping of a 230 cubic metre barge load required 40 to 50 minutes, or even more.

Researches were undertaken in 1933, in collaboration with the firm of Bergeron, which led to the production of a new type of spoil pump, "Bergeron—Ponts et Chaussées Nantes." Installed in the place of the two old pumps, one of these new pumps allowed an increase of the pumping distance from 900 to 1,800 metres at least, and at the same time reduced the pumping time per 230 cubic metre barge from 50 to 25 minutes. The paper deals with the problems investigated in arriving at this good result.

A rather complete study is reported on the whole question of pumping and the density of mixtures. It is pointed out that loose materials (coarse sand, pebbles and gravel) enter a suction mouth easily, and it is their behaviour in the suction pipe and transmission pipe which limits the concentration of the mixture. On the other hand, materials which are easily pumped when in the pipes, such as fine sand and mud, are not readily drawn into the mouth of the suction pipe, which fact again limits the concentration. A pump of given power, discharging into a pipe of given diameter with a given head, can only pump a definite type of spoil to a given distance, but this maximum "lead" varies between wide limits, perhaps differing by 100% (with constant power, the same material and the same amount of solids discharged) according to the "characteristics" of the pump used.

On the other hand, the maximum "lead" is well known to depend on the granular condition of the spoil and the concentration of the mixture as sucked. A plant capable of pumping fine sand and mud to a great distance may only be able to discharge pebbles and gravel to a small distance and in weak mixtures. One finds, moreover, with the old type of pump that the total discharge decreases, for a given "lead," according as the concentration is forced up, or as the grains become larger and larger. The same thing happens if, other things being the same, the pipe is lengthened. These reductions in the discharge of the solids influence costs, but the occurrence of blockages is still more important, suspending the operation of the plant, as well as other units working in conjunction therewith, sometimes for two or three days. The introduction of slopes, pressure water or rifling have only minor effects. *Choking and the reduction of discharge with lengthening of the pipe or the increase of concentration are connected with the characteristics of the pump, and the only remedy is to adapt in the best possible manner these characteristics to the conditions of flow of mixtures in forced régime.*

The Author then goes into the question of the flow of mixtures in closed pipes, making particular use of O'Brien and Folsom's well-known paper of 1937, which, it seems, generally confirms the results found in 1933 by Messrs. de Frondeville and Siegfried at Nantes.

A very important conclusion from this work is that the loss of head per unit length of pipe is *not* dependent on the concen-

tration as long as all the material is in a state of suspension, i.e., while there is no deposit on the bottom of the pipe. The loss of head is not quite the same thing as loss of pressure, since the density of the mixture is higher than that of water. This can be eluded by expressing pressures as head of mixture. *In total suspension the turbulence keeps the material suspended, and the hydraulic gradient does not differ from that in clear turbulent water.* If, however, the mean velocity falls below a certain limiting value, corresponding to a certain discharge, part of the material settles out, and while the velocity continues to decrease a deposit grows on the bottom of the pipe, with a more or less wavy surface.

At the same time, in the proximity of this limiting velocity the loss of head at constant concentration *ceases* to decrease with decrease of the discharge: it passes through a minimum as the discharge is decreased, and then *increases* as the mean height of the deposit increases, in spite of decreased velocity. (See Fig. 1).

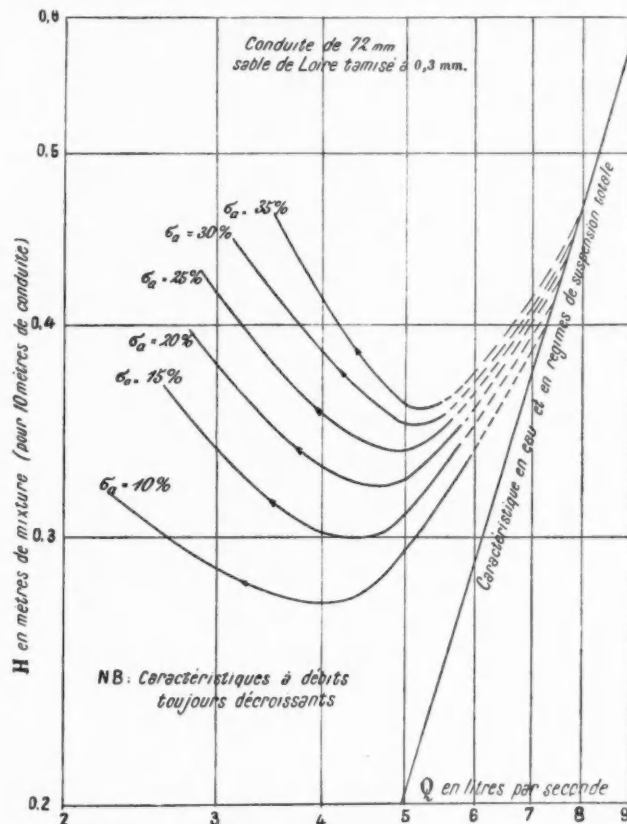


Fig. 1. Head losses in mixture. (Siegfried's experiments)

72 mm. pipe.

Loire sand screened to 0.3 mm.

H. in metres of mixture (per 10 metres length of pipe).

$\sigma_a$  = concentration in bulked volume of sand per unit volume of mixture.

Straight line = characteristic of the pipe line in water and in regimes of total suspension.

Q in litres per second.

N.B.—Characteristics for continually decreasing discharges.

It will be observed that, with decreasing discharge, for any particular value of the discharge the loss of head increases with the concentration of solid in the mixture.

When, however, the change is reversed and the discharge is increased, the relations are not the same. According to Siegfried, for all régimes compatible with a constant thickness of deposit, the loss of head is independent of the concentration, and varies as the square of the discharge. In other words, an additional head is required to restore the flow and cut away the deposit. This is the old fact that a higher velocity is required to disturb a river bed than to keep the same material suspended.

There is then a critical velocity at which the loss of head in the mixture commences to differ from the loss of head in water.

This velocity depends on the granulation of the material and the turbulence. It is close to (but not identical with) the velocity at which deposit begins, and not far from the velocity at which the head discharge curve has its minimum. The differences between these three velocities, which mark the transition zone from total suspension to the formation of a deposit, may often be neglected. The critical velocity does not depend to any important extent on the diameter of the pipe, but does depend on the roughness of the surface.

The characteristic "head-discharge" of the pump is next considered and compared with that of the pipe. This comparison is the essential feature of the analysis. (See Fig. 2).

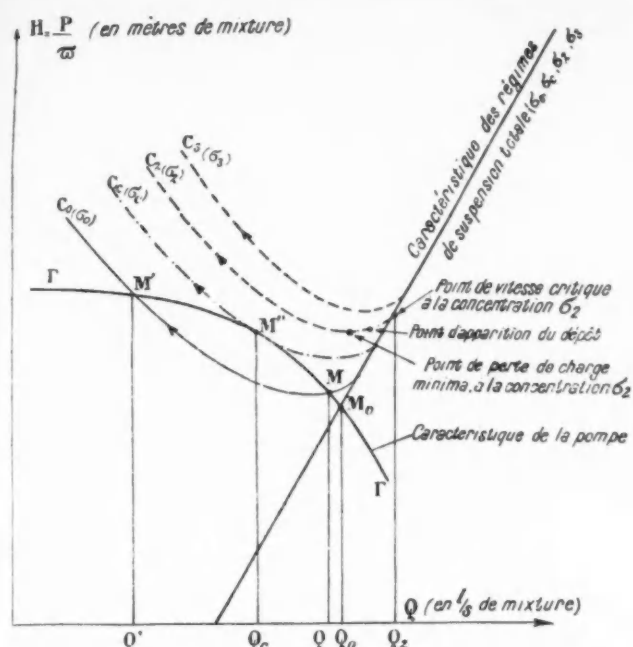


Fig. 2. Functioning of a Spoil Pump associated with a discharge pipe H in metres of mixture.

C the "characteristics" of pipe for various concentrations of mixture  $\sigma$ .

On  $C_2$  are shown the

Point of critical velocity for the concentration  $\sigma_2$ .

Point of appearance of deposit.

Point of minimum loss of head for the concentration  $\sigma_2$ .

I, the characteristic of the pump.

Q, the discharge in litres of mixture.

From the diagram it will be seen that there is a certain concentration ( $\sigma_c$ ) at which the mixture will not pump, so that for a certain pipe line with given material there is a critical concentration which cannot be exceeded without the flow being checked and material being deposited in the pipe. The corresponding critical discharge (and hence a second kind of critical velocity) is indicated at the point "M" on the curve.

It is clear that according as the pump characteristic changes, the critical concentration, and with it the maximum "lead," also changes, and the paper next discusses pump characteristics of three ideal types:—

A.—Constant Head.

B.—Constant Discharge.

C.—Constant Power.

It is assumed that for total suspension the characteristics of pumps are practically the same in the mixture as for clean water, and a future paper is promised, relating to the performance of the Bergeron pumps, wherein it will be shown that there are pumps for which this condition is sufficiently true over a large part of the curve.

The Author then examines in considerable detail the various conditions arising from different combinations of pump and pipe-line characteristics, and points out the several limits which occur.

Cavitation is next considered in relation to both suction dredging and spoil pumping. Some interesting figures are given concerning the vacuum of the dredger "Pierre Lefort." It is noted that the vacuum at the eye of the pump should be kept as low as possible (provided it is sufficient to overcome the hydraulic resistances), that the suction pipe should rise but little or not at all above the eye of the pump, and that the eye of the pump should be at as low a level as possible. If the spoil is being pumped from barges, the dilution water and cutting jets should be supplied by nozzles dipping into the spoil so as not to entrain large quantities of air in the mixture. "Stone boxes" are objectionable, from the point of view of cavitation.

The new pumps have proved capable of maintaining without cavitation a vacuum of 7 metres (21 inches of mercury), with a pumping pressure on the discharge side of 60 metres (90 lbs. per sq. in.).

It is claimed that their efficiency is of the order of 75%, as against some 60% for the older type, and that by reason of better flow the wear is less. With the old pumps, new liners were necessary after the pumping of 120,000 cubic metres of the Loire sand, while in some of the new pumps with ordinary steel liners already 450,000 cubic metres have been pumped, and this may perhaps be doubled before the liners need renewal. The use of shrouding to the impellers is shown to have a very beneficial effect on the maintenance of head in spite of wear. For large pumps shrouding involves the use of a special thrust bearing, and the special pumping of clear water into the space between the shroud and the pump casing. If the spoil is lumpy half-shrouded impellers may be advisable. As to the large

passages in the old type of pump, it is suggested that these are not really necessary, and that the grid in the suction pipe-mouth should suffice. Furthermore, a stoppage is less likely to cause fracture in a shrouded impeller, as the object cannot pass through to the periphery and simply rotates with the impeller.

The use of special metals is strongly advised. The Bergeron pumps have chrome steel impellers which, after pumping 500,000 cubic metres of Loire sand, show a mean wear of less than 5 mm. thickness. The volute chamber does not form part of the actual pump casing, which needs to stand great pressure and therefore cannot allow much wear. The volute chamber is of manganese steel, practically direct from the foundry, and is placed in one piece inside the pump casing, which is of ordinary cast steel. Volute chambers have shown no perceptible wear after pumping more than 1,000,000 cubic metres of sand, although mixtures up to over 25% volume concentration have been passed through the pumps at velocities higher than usual.

The paper concludes with some remarks on the guarantees which may be demanded from contractors doing reclamation work, in view of the improved apparatus available.

No dimensions are given of the new pumps, and the only illustration is an external photograph.

H.C.

### Book Review

**Mechanische Hafenausrüstungen** insbesondere für den Umschlag (Mechanical Harbour Equipment, especially for cargo handling), by Oskar Wundram, Chief Structural Adviser, Hamburg; pp. v. + 173; 153 illustrations; 1939; Berlin, Julius Springer. Price: 18 Reichsmarks.

This is an excellent handbook on the subject of Harbour Equipment. It opens with a discussion as to the nature and scope of the various appliances required in a modern harbour, and the manner in which they depend on the number, size and type of ships served and the peculiarities of the harbour itself.

Next follows a brief but sufficient description of the plant for the maintenance and security of the harbour, such as dredgers, ice-breakers, diving and salvage equipment, pile drivers, tide indicators, fire and sanitary services and repair shops.

The major part of the book deals with apparatus for the rapid and economic handling of cargo. General principles are considered, and then the different methods of power supply and control of machines. Lighting, heating and air-conditioning are then treated.

The subject of wharves for handling general cargo is next dealt with, followed by a study of the various types of cranes, ships' derricks, conveyors and trucks. Layouts for goods handling are well discussed.

The next section of the book deals with bulk cargo which can be "shot" (e.g., coal, minerals, grain, oils). Grabs of various types on rotary and bridge cranes, coal tipplers, belt and bucket conveyors, suction plants for grain handling, and special coal bunkering devices are described. Layouts for the handling of coal, minerals, grain, chemicals and oil, follow.

The equipment for the operation of locks, moving bridges, tunnel services, lifts and escalators is then considered.

There then follows a section on tenders and tugs, harbour railroad devices, landing stages, light towers, fog signals, time signals and distant transmission of signals.

The book closes with an excellent discussion of the economics of harbour operation, including dues, costs of handling bulk and general cargo, maintenance costs and the general financial problems of design.

The price is rather high for a descriptive book, but it is a very good general guide to modern harbour practice.

### A New Radio Fog Signal in Boston Harbour.

Experimental service tests of a battery-operated short-range radio beacon transmitter, fitted to a large buoy, are now being made in Boston Harbour. In the main ship channel off Deer Island, an ordinary buoy containing a miniature radio transmitter has been placed by the Lightship Service. It is designed to eliminate risks to fog-bound ships.

The radio beacon transmitter, the special antenna, and the lay-out of the power supply were developed at the Lighthouse Service's radio laboratory. Preliminary tests, using adaptations of commercial equipment, were made in New York Harbour some two years ago.

This new signalling unit is placed in a watertight container, and then sealed into the buoy. The aerial emits signals consisting of five dashes every 15 seconds on a frequency of 310 kcs., and incoming ships can pick up the signals and trace the position of the guide buoy on a chart.

There are many places where well-developed and reliable radio beacons on buoys could serve as better navigational aids than other guides which could be installed at a reasonable cost. It is stated that the apparatus is the only one of its kind, and if the results of this test prove satisfactory, it is anticipated that similar installations will be placed in many of the navigable harbours of the United States.

# Construction of a New Quay at the Lock Entrance Albert Edward Dock, North Shields\*

By R. B. PORTER, B.Sc., Assoc. M. Inst. C.E.

(continued from page 240)

## Lock Entrance Wall

The lock entrance wall had to be reduced in height by 1-ft. 2-in. to enable the quay surface in front of the transit shed to be finished at the same level as the rest of the work which followed that of the Tyne Commission Quay. This necessitated the removal of the granite coping course. The stones, which measured about 4-ft. by 4-ft. by 2-ft., were freed by driving steel wedges into the bed joints, and afterwards lifted clear from floating craft. Blasting was tried, but although this freed the stones more rapidly, considerable damage was done to the edges of the course below. This did not matter in the case of the removal of the coping bordering the triangular ferro-concrete quay, already described, as the wall there is out of sight. The coping was rebuilt to the new level in mass concrete, the timber shuttering being secured by bolts grouted into the wall about one course down. The section of wall behind the new coping was dressed level and filled with concrete to form a solid bed for the front crane rails.

Several cracks which had shown on the face of the wall for some years were carefully raked and washed out, and pointed above low-water level with cement mortar. Below this they were plugged by a diver, using a mixture of equal parts of clay and quick-setting cement. Neat cement grout was then poured in from an opening at the top. One of these cracks was about 1-in. wide, and required four tons of cement (weighed dry) before the filling overflowed at the top, and no longer showed signs of leaking above or below water.

Mooring Bollards were placed along the wall at intervals of 90-ft. and fixed as shown on the slide. The bolt holes were bored with pneumatic tools, worked from staging hung over the side.

## Removal of Concrete Haunching over the Toe of the Lock Entrance Wall

Following some preliminary dredging along the front of the wall, a diver was sent down to make a thorough examination along the base. He discovered that for a distance of 160-ft. the toe was protected with slag concrete which had evidently been deposited during, or some time, after its construction in 1882. In order to give the required depth of 22-ft. below L.W.O.S.T. alongside the wall, a part of this concrete had to be cut away. The cutting was done by diving bell, using hand and pneumatic appliances, and the procedure adopted was to land the bell against the wall over the high part of the concrete slope and sink it by cutting a chase round the periphery, after which the dumping was removed by chisel and hammer. The broken concrete was pushed down into a trench previously excavated by grab dredger. This method was found to be much easier and quicker than lifting the material into the bell and raising it to the surface. Two 8-hour shifts of two men each were worked daily, except Sundays, and the work was completed in four weeks.

The following particulars of the diving bell used may be interesting, viz.:—

Internal dimensions: 8-ft. by 6-ft. by 5-ft. 6-in. high, less 4-in. all round for thickness of ballast blocks.

Weight in working order: 12 tons 10 cwts.

Maximum speed of lifting: 10-ft. per minute.

Provision inside for two sets of 3-ton chain blocks.

Equipped with 12-volt Loudaphone telephone set.

Interior illuminated by means of two 100-watt lamps.

Owing to difficulty in mooring the craft, the bell was used, for the most part, with its short side against the wall.

## Floating Fenders

Shortly after the opening of the Tyne Commission Quay, the Shipping Company requested the provision of floating booms or fenders to protect the paintwork of their ships against damage from contact with the fixed fendering.

At the Extension Quay, six fenders have been provided, not only for this purpose but also for the very important one of keeping the submerged part of ships clear of the battered wall.

These are 42-ft. long by 3-ft. wide, and consist of pitch pine and Oregon logs—a 12-in. by 12-in. bolted to a 12-in. by 6-in. in front with a 12-in. by 12-in. at the back, the 6-in. space between being filled in with rubber and steel washers threaded over 1½-in. diameter bolts at 9-ft. centres, which are counter-sunk about 2-in. into the face timber to prevent the ends projecting and damaging a vessel when the fenders are squeezed. Specially shaped cover plates are coach screwed to the ends of the front section as a protection against end splitting. The fenders are fastened to the quay by means of two No. ¾-in. diameter chains at 35-ft. centres, hung from eye bolts fixed near the top of the wall, or fixed timber fendering in the case of the ferro-concrete section. The chains are weighted with cylindrical bars weighing about 1-cwt. each. Cast-iron thimbles, spaced to suit the chain centres, are fitted in the back of the fenders. Free movement with the tide is thus obtained and no drifting out or tipping takes place.



Fig. 6. Re-erection of Hydraulic Accumulator

## Railways

The whole of the railway system leading from No. 2 passenger road is new, with the exception of the three tracks along the North dock wall, which were re-sleepered and re-ballasted. The new railways are laid with 90-lb. B.S. section flat-bottom rail spiked through ½-in. bearing plates to timber sleepers laid on a 6-in. formation of ashes. Within the paved areas, bulb-angle guard rails are bolted to the running rails to give the usual flangeway clearance. Where the concrete decking joins the river wall the rails are laid on longitudinal 12-in. sq. timbers, the gauge being maintained by 3-in. by 0½-in. tie-plates at 5-ft. 3½-in. centres, through which the rails were alternately spiked and screwed.

The congested nature of the site and the large number of different works proceeding at the the same time made it difficult to lay the railway track. On several occasions rail access to the works was temporarily severed, and floating craft had to be used for disposing of the excavated material. The excavation for the railway work was 3,000 cu. yds.

\* Paper read before the Newcastle and District Association of the Institution of Civil Engineers on February 7th, 1939.

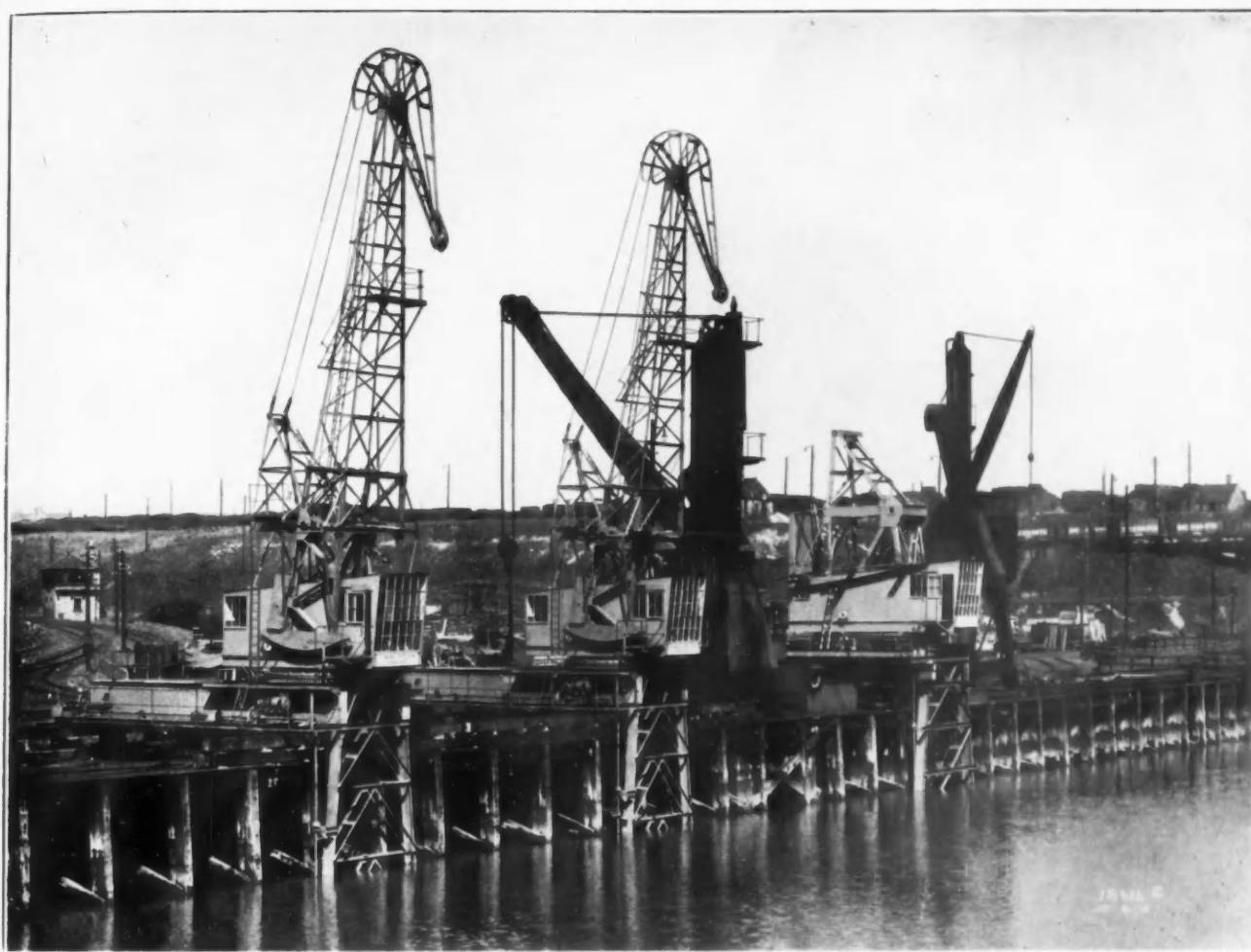
*Construction of New Quay, Albert Edward Dock, North Shields—continued*

Fig. 7. Erection of Quay Cranes

**Pipe Subways**

A mass of hydraulic and other underground supply mains which led to the accumulator at the old engine house came within the paved area and had to be diverted into subways where access to them would be possible in the event of a burst. In designing the subways, it was possible to use as side walls several of the existing walls inside the old building, with consequent saving of concrete. The subways are about 3-ft. deep, and vary from 2-ft. 6-in. to 3-ft. in width, according to the number of pipes accommodated. They are covered with 6-in. reinforced concrete slabs laid flush with the surrounding paving.

**Approach Road and Paving**

The approach road and paving, where clear of the railway lines, is of in-situ reinforced concrete construction. Work on this was commenced as soon as the various areas to be covered had been cleared of plant, etc. Excavation was chiefly made in ground composed of a mixture of gravel, clay, and soft earth. The formation was thoroughly consolidated with a hand roller weighing about 10-cwt., and covered with a 3-in. layer of ash, and rolled again. Concreting was carried out on the alternate-bay system, the bays, where possible, being made 40-ft. long by 18-ft. wide. The concrete was deposited in two layers, the lower being 7-in. thick and the upper 2-in. thick, except on the cambered sections of road where the lower layer is 5-in. thick at the edges. The road is reinforced throughout with B.R.C. fabric No. 64, placed about 2-in. above formation level. The copper strip in the transverse expansion joints is to prevent water soaking through, the centre corrugation permitting free movement between the bays without risk of fracturing the strip. After concreting, each bay was completely covered with a layer of hessian, which was damped and left on until the concrete had hardened. After removing the cloth, the bays were covered with wet sand.

The large area of paving behind the transit shed required careful treatment in order to ensure satisfactory drainage, and this was the main factor in determining the arrangement and shape of the bays. The gullies are so placed that the slope in any direction is at least 1-in. in 10-ft. The work was very carefully carried out, and the surface is now free from pools.

At the railway crossings the road was stopped 2-ft. 6-in. from the outer rails and the raft thickened to 15-in. for a width of 12-in. from the edge. The crossings are paved with Baltic

redwood creosoted railway sleepers spiked to the under sleepers, the difference in height between the rails and sleepers being made up with hardwood packing.

**Kerbing**

The kerb along the West side of the approach road was constructed in pre-cast sections, 3-ft. long by 10-in. wide by 8-in. deep, battered 1-in. on the road face. A projecting strip was formed on the underside of each kerb to correspond with the chase moulded along the projecting raft of the carriage-way into which the kerb sections were grouted.

**Pre-cast Paving**

Between the railways at the front and back of the transit shed, pre-cast 4-in. reinforced slabs were used. Owing to the lack of working space near the contract site, the slabs were made inside a grain warehouse situated on the other side of the dock where, on the ground floor, there was sufficient room for the mixer and the materials required. This had the added advantage of enabling the work to be continued irrespective of weather conditions, which were particularly severe during the period of the contract. The slabs were made 2-ft. 7½-in. long to conform with the sleeper centres of 2-ft. 8-in. The widths were varied according to position, the maximum being 4-ft. 3½-in. The slabs are reinforced with a single layer of 3-in. mesh expanded steel, weighing 11½-lb. per sq. yd., and placed 1-in. from the underside. They were cast one on top of the other, partly due to the limited space available, and partly because their great area in proportion to their thickness might have rendered them liable to strain had they been lifted or tilted soon after concreting. Forms made of 4-in. by 3-in. timber with detachable sides were constructed and laid singly over the floor. About 36 hours after concreting, the surface of each slab was lime-washed and covered with a layer of oiled brown paper. The shutters were then moved up in readiness for concreting the next set of slabs. In this way 12 slabs were cast in one pile. Tapered plugs were set in the slabs to form holes for lifting bolts. After maturing for over two months the slabs were conveyed to the site, laid between the railways on a bed of sand and carefully tamped to the required level.

**Drainage**

A 6-in. sanitary drain was laid from the new Customs and shipping offices along the West side of the approach road and

### Construction of New Quay, Albert Edward Dock, North Shields—continued

continued in a straight line under the concrete paving to a manhole at the South-east corner of the transit shed. From there to the outfall in the old river wall the size was increased to 9-in. This main drain is joined by 6-in. drains leading from the front and back of the shed, to which are connected the various gullies and open-jointed cross drains running under the railways.

#### Drawbridge

The drawbridge or "movable gangway" might be described as a steel-framed bogie 2-ft. long by 10-ft. wide, carrying a timber-decked platform mounted on a system of rockers such that it can be raised up to the level of the shed platforms by hand gear in one operation. As the new Oslo shed platform is 3-ft. 8-in. high and the passenger platform 2-ft. 11-in., the gearing is arranged to lift the bridge more one end than the other, which was done by proportioning the lengths of the rocker arms to the lifts required at each end. The under-carriage travels on three pairs of 18-in. diameter wheels, the three on one side being centrally flanged to run on a track consisting of angle bars grouted into the concrete paving, the others have plain treads. To enable the front part of the bridge to cross the railway lines, including one pair of points, without bumping, two of the axles are mounted close together at the front end of the bridge. The bridge track was laid  $\frac{5}{8}$ -in. above the railway lines to avoid notching the rails for the wheel flanges. The upper platform is fitted with collapsible hand-railing in the form of hinged angle stanchions connected by light chain.

The bridge when not in use is housed in a recess under the Oslo shed floor. Hand-travelling gear is fitted, but as the wheels run in ball bearings, the bridge can be pushed by one man with little effort once it has been started. The time required to move out the bridge, raise the platform and erect the hand-railing, is about four minutes.

The difference in floor level between the two sheds was really the deciding factor in the adoption of this form of bridge.

#### Turntable

The turntable, which is 15-ft. in diameter, is of cast iron with removable chequered steel cover plates for access to the roller track, and is equipped with a single track and the usual registering pawls and wheel stops on the approach lines. It is mounted in a reinforced concrete pit formed in the reinforced concrete decking of the adjacent Tyne Commission Quay. The pit is 2-ft. 7 $\frac{1}{2}$ -in. deep by 15-ft. 9-in. internal diameter, the floor being 6-in. thick, with the portion under the turntable pivot thickened to 1-ft. 6-in. The work entailed cutting through the R.C. beams which carry the two lines of railway and a very elaborate system of strutting had to be erected to support the surrounding decking and to permit uninterrupted use of the independent passenger line alongside the station platform. The beams were reconstructed in modified form under the pit floor. The work was very successfully carried out, and there is still no sign of cracking.

The turntable and drawbridge are fitted with locks operated by a key which is electrically released from the signal box at the South end of the Tyne Commission Quay. Release cannot be given until certain signals controlled from the signal box have been locked in the "on" position by what is known as a "king" lever.

#### Other Works

Other works carried out in connection with the quay construction are as follows:—

- (1) Re-erection of the hydraulic accumulator on a piled foundation at the South side of the dock. (See Fig. 6).
- (2) Construction of a new ferry landing with waiting-room for cross-river traffic at the North end of the Tyne Commission Quay. This consists of timber stringers with steel treads supported on a landing platform, which is connected by steel straps to the cruciform piles.
- (3) Laying underground electric power and lighting cables for the cranes and shed from the Commissioners' power station at the South side of the dock, about a quarter of a mile away. The electric cranes were erected on a timber jetty inside the dock, and when completed were lifted by the Titan crane and placed in their final position ready for working.

The 1 $\frac{1}{2}$ -ton electric capstans are each mounted in a pre-formed concrete well having 9-in. side walls. The fair-leads are bolted to concrete blocks 3-ft. 6-in. square by 2-ft. 6-in. deep, constructed *in situ*.

#### Cranes

Owing to the short time allowed for the construction of the quay, the cranes had to be erected away from the quay site. The site selected by the crane contractor was the old passenger jetty in Albert Edward Dock which, incidentally, was built for the Norwegian Mail Boat service about 35 years ago. It was an ideal place for the work, there being rail access, a 23-ton

crane which enabled the contractor to complete at his works such assemblies as the under-carriages, cabins, and jibs, and after delivery to the jetty, to lift them bodily into position from rail wagons alongside. After completion, the cranes were lifted by floating craft and landed on the new quay when the work was sufficiently advanced there to receive them. (See Fig. 7).

Particulars of the cranes are as follows:—

10-ton Crane:—Weight, 105 tons; maximum radius, 52-ft.

1 $\frac{1}{2}$ -ton Crane:—Weight 52 tons; maximum radius, 49-ft., but outreach same as 10-ton, i.e., 38-ft.

#### Concrete Mixtures Used

Octagonal piles, bracings, deck beams and decking:—187 lb. (one bag) of cement to 3 $\frac{1}{4}$  cu. ft. of sand and 6 $\frac{3}{4}$  cu. ft. of gravel ( $\frac{1}{8}$ -in. to  $\frac{3}{4}$ -in. grading).

Top 2-in. of road paving, decking and shed floor surfacing:—187 lb. (one bag) of cement to 3 $\frac{1}{4}$  cu. ft. of sand and 6 $\frac{3}{4}$  cu. ft. of whinstone ( $\frac{1}{8}$ -in. to  $\frac{3}{4}$ -in. grading).

Foundations and platform walls:—One bag of cement to 4 cu. ft. of sand and 8 cu. ft. of gravel ( $\frac{1}{8}$ -in. to 1 $\frac{1}{2}$ -in. grading).

Shed floor filling:—One part of cement to 10 parts of un-screened ballast.

Motor road (bottom layer):—One bag of cement to 4 cu. ft. of sand and 8 cu. ft. of gravel ( $\frac{1}{8}$ -in. to 1-in. grading).

Medium-setting cement was used for the major part of the work, but where quicker hardening was required, rapid-hardening Portland cement was employed. All sand was specified to be mixed in the proportions of one part of sea sand to one part of river sand, the two being kept separate until mixed for concreting. The gravel was obtained from the upper reaches of the Tyne, and the whinstone from Northumbrian quarries.

The principal contractors for the work were Messrs. Brims & Co., Ltd., of Newcastle-on-Tyne. The writer acted as resident engineer under the direction of the Commissioners' Chief Engineer, Mr. R. F. Hindmarsh, M. Inst. C.E. Messrs. L. G. Mouchel & Partners, Ltd., designed the reinforced concrete quay section, the remaining work being designed by the Commissioners' staff.

The quay was formally opened on June 29th, 1937, by the Chairman of the Tyne Improvement Commission, Sir Arthur Munro Sutherland, Bart.

### Publications Received

Bulletin No. 1, issued by the recently-formed Engineers' Guild, contains a report of the first meeting of the Guild since its inauguration on May 16th last. The discussion ranged over a number of topics, including the difficulties arising from misappropriation of the title "Engineer"; the control of the number and quality of entrants to the profession; the enforcement of discipline in matters of professional conduct; the inducing of engineers to come out of their professional shell, and the proper representation of the profession in public affairs. The Hon. Secretary of the Guild is Mr. V. B. Marley Mason, with offices in 1, Central Buildings, Westminster, S.W.1.

Field Engineering Bulletin, No. 12, December, 1938, issued by the United States Coast and Geodetic Survey, contains a message from the new Director, Mr. L. O. Colbert, dealing with the present position and needs of the Survey, followed by a variety of articles, including a reprint of Lt.-Comdr. MacMillan's article on Echo Sounding in Harbour Hydrography, which was first published in the August 1938 issue of this Journal.

The Hydrographic Review for May (Vol. XVI., No. 1), published by the International Hydrographic Bureau, Monaco, has a number of interesting contributions on special aspects of marine surveying, including a reprint of the Section on the Theory of Bars from the Vernon-Harcourt lecture of the Institution of Civil Engineers on Estuary Channels and Embankments.

A copy of the 8th Edition of Myhre's Handbook of Baltic and White Sea Loading Ports, edited by Mr. G. Tofte, has been received from the Publishers, Messrs. J. Jorgensen & Co., of Copenhagen. The new issue contains 1,120 pages, including a number of maps, and is retailed at 35s. Full particulars are given concerning conditions, port charges and other expenses in ports and loading places in Sweden, Finland, Russia, the White Sea, Estonia, Latvia, Lithuania, Danzig, Poland, Germany, Denmark, Norway, Belgium and Holland, including the important discharging ports in Great Britain.

The book has been carefully revised, and a great deal of new material added. The contents will afford shipbrokers, owners and captains, useful assistance in ascertaining beforehand the conditions prevailing and the expenses which will be incurred at any of the hundreds of ports described.



# LEIXÕES HARBOUR.

(PORTUGAL)

## EXTENSION OF THE NORTHERN MOLE.

ENGINEER-IN-CHARGE FOR THE MINISTRY OF MARINE; - SENHOR DUARTE ABECASIS (I.S.T.)

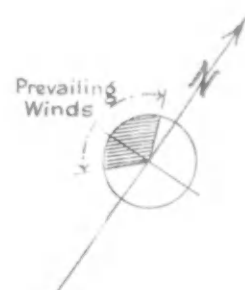
+4.20 H.W. max. S.T.

+0.20 L.W. max. S.T.



### REFERENCE.

Extension of Northern Mole coloured RED.

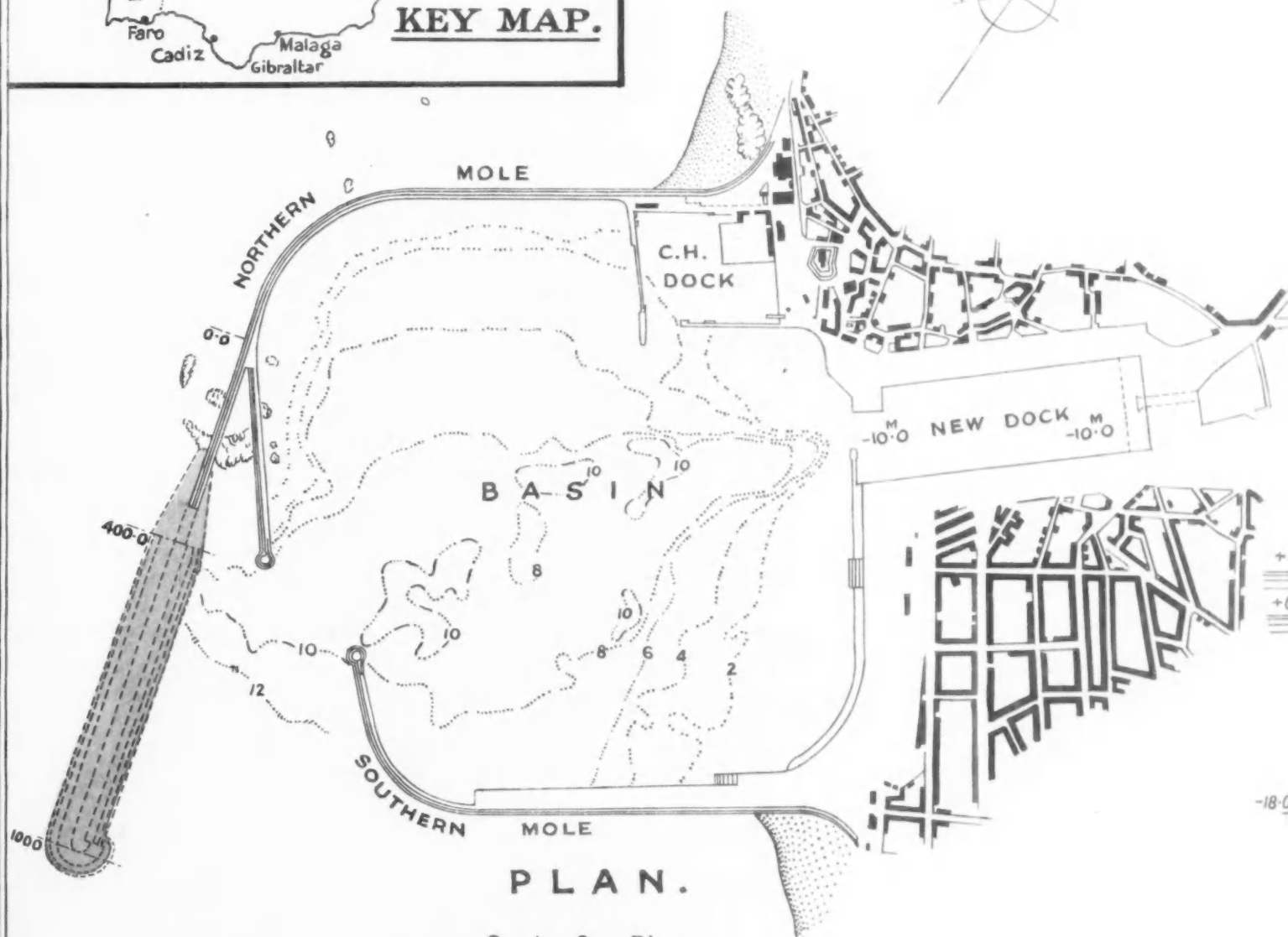


+4.20 H.W. max.

+0.20 L.W. max.

+4.20 H.W. max.

+0.20 L.W. max.



+4.20 H.W. max. S.T.

+0.20 L.W. max. S.T.

+4.20 H.W. max. S.T.

+0.20 L.W. max. S.T.

+4.20 H.W. max. S.T.

+0.20 L.W. max. S.T.

METRES 100 50 0 100 200 300 400 500 600 700 800 900 1000 METRES

# HARBOUR.

UGAL)

HE NORTHERN MOLE.

## CROSS SECTIONS OF BREAKWATER.

OF MARINE;- SENHOR DUARTE ABECASIS (I.S.T.)

### REFERENCE.

Extension of Northern Mole coloured RED.

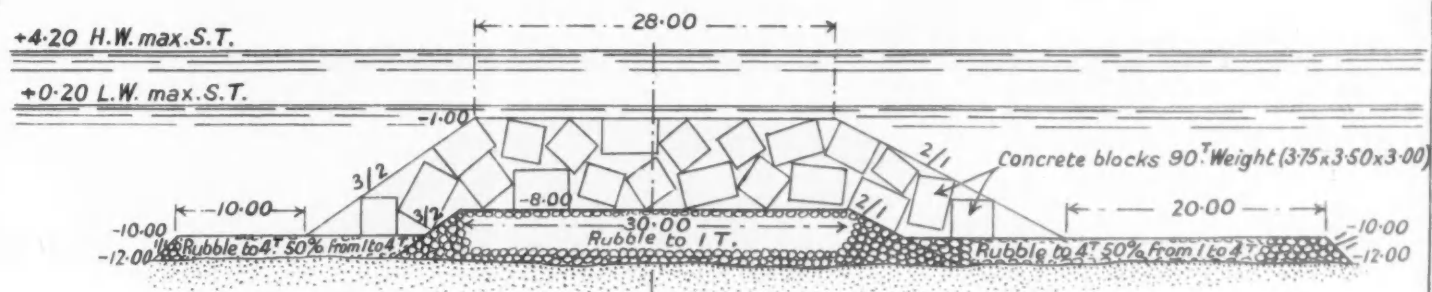


FIG. 4 - DEPTHS OF -12.00 M

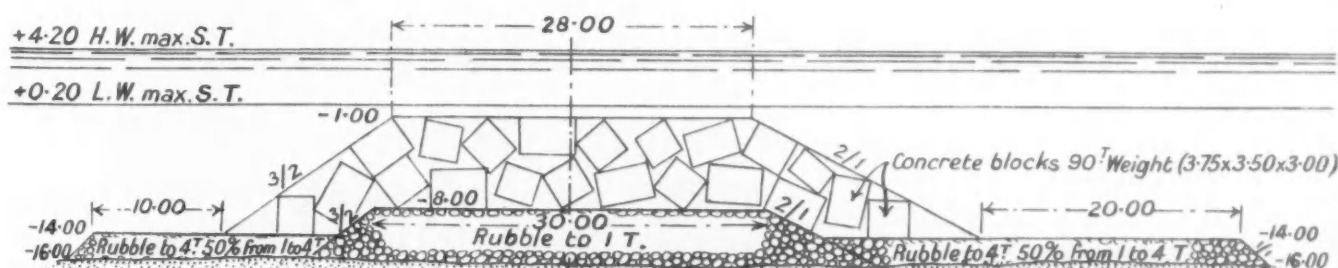


FIG. 5 - DEPTHS OF -16.00 M

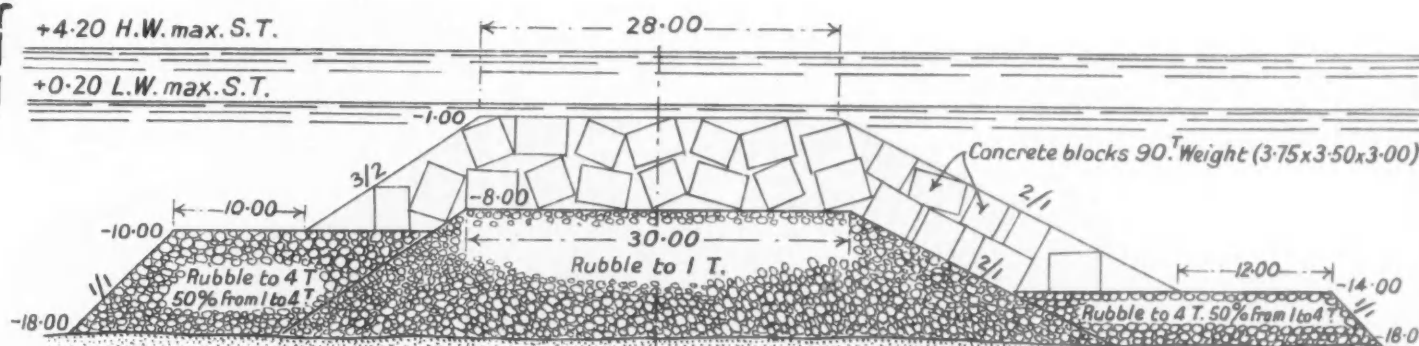
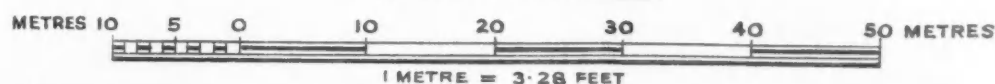


FIG. 6 - DEPTHS OF -18.00 M

Scale for Sections.



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## Notes of the Month

### New Quay at the Port of Haugesund.

A new quay, 600-ft. in length and 50-ft. in width, is to be constructed at the Port of Haugesund, Norway. The total cost is expected to amount to approximately 500,000 kr.

### Extensions at the Port of Kallundborg.

The Port of Kallundborg, Denmark, is to be improved and extended at the cost of approximately 1,500,000 kr. At the same time, the depth of the fairway is to be increased from 26-ft. to 30-ft.

### Bills of Health for Panama Canal Transit.

A statement has been issued that on and after 15th August next, all vessels arriving at the Panama Canal must have Bills of Health issued by United States Consuls at the first port of departure, and also at subsequent ports of call. Also sanitary statements must be issued from all United States ports.

### Annual Meeting of Dundalk Harbour Trust.

Speaking at the recent annual meeting of the Dundalk Harbour Trust, the Chairman said the financial position of the Trust was exceptionally sound, and the balance sheet showed a surplus of assets over liabilities of £16,995. Mr. McGahon was re-elected Chairman, and Mr. Deery, Vice-Chairman, and the accounts were adopted unanimously.

### Increased Turnover at the Port of Dairen.

The transit traffic at the Port of Dairen (Manchukuo) attained its highest figures on record for the financial year ended 31st March, 1939. Exports totalled 5,425,938 tons, and imports 4,179,512 tons. Compared with the preceding year, the general increase is 447,027 tons, or 4.8%. If these figures are compared with 1930, when imports only totalled 800,000 tons, it will be realised how greatly trade has developed at Dairen during the last nine years.

### Staff Appointments at Port of Bristol.

The Port of Bristol Authority has decided that the position of Assistant General Manager, vacant by the death of Mr. Frank Brown, shall not be filled, and the following new arrangements have been made. Mr. F. D. Arney, assistant secretary, becomes assistant to the General Manager, the appointment dating from February 1st. Mr. W. G. Neale becomes general assistant to the Secretary, and Mr. J. A. Philpott has been made accountancy assistant to the Secretary. Also the positions of traffic agent and traffic manager at the City Docks have been regraded.

### Further Improvements Contemplated at Buncrana Harbour.

With the object of deepening and enlarging Buncrana Harbour so that it will be capable of accommodating shipping bringing cargoes direct from the West Indies, the Government of Eire is considering further expenditure. An inspection of the harbour has been carried out by a Board of Works Engineer, and a second Engineer is to be sent to take soundings and measurements at the pier, following which there will be a conference in Dublin to consider the financial aspect of the proposed improvements. The harbour was reconstructed some years ago at a cost of £36,000.

### Trade at the Port of Vancouver.

Vancouver's outstanding position as a seaport is emphasised in the Report recently issued by the National Harbours Board of Canada. Of all the water-borne cargo tonnage credited to the eight ports under the Board's control, Vancouver handled approximately one-fifth, and stands second only to Montreal in port business. In the tonnage of vessels arriving and departing, Vancouver is ahead of Montreal, the relative totals for 1938 being 11,620,493 tons for Vancouver, compared with 8,589,919 tons for Montreal. Vancouver, while heading the list in coastwise passenger traffic, is second to Montreal in shipping arrivals (coastal and deep-sea) and in port revenue.

### Improvements to the Brownsville Ship Channel.

Tenders were recently opened in Galveston, U.S.A., for the further development of the Brownsville Ship Channel and turning basin. According to the terms of the contract, the fairway channel will be deepened to a depth of 32-ft. below mean low tide over a bottom width of 300-ft. The ship channel to Brownsville, as well as the turning basin, will be dredged to a depth of 30-ft., with 1-ft. extra as margin. The work entails the removal and disposal of approximately 6,245,000 cu. yds. of material, and includes the dredging of two additional basins in the Brownsville Channel. These basins will be approximately 2,000-ft. long and 600-ft. wide at water line, and approximately five miles apart from each other, and will serve as turning basins for dredgers, and as passing places for ships using the channel.

### Reconstruction of Wharf at Quebec, Canada.

The National Harbours Board of Canada recently awarded a contract for the reconstruction of the St. Charles River Wharf and Shed No. 28. The new shed will be 560-ft. long and 108-ft. wide. The work is expected to be completed in the near future.

### New Dry Dock at Genoa.

The new dry dock at Genoa, which has been under construction since 1935, is now completed. The dock measures 919-ft. in length by 138-ft. in width. If necessary, the length can be increased to 1,150-ft. It was the subject of a descriptive article in the issue of this Journal for April last.

### Extensions at the Port of Majunga, Madagascar.

The French Minister of Colonies recently placed a contract with the Société Schneider for extensive improvements at the Port of Majunga. The scheme includes the construction of a quay having a depth of 10 metres (32.8-ft.) alongside, and the construction of a southern protective dyke, which will be put in hand as soon as a study of the local currents is completed. The total cost of the port work is estimated at 3,000,000 francs.

### New Jersey Intracoastal Waterway to be Deepened.

In the Rivers and Harbours Bill recently submitted to the U.S.A. House of Representatives, provision is made for the Federal Government to take over the New Jersey Intracoastal Waterway, from Manasquan Inlet to Cape May, and for the extension of the waterway to Delaware Bay by a canal. It is proposed to deepen the entire waterway to a depth of 12-ft. at mean low water, and the initial cost of the scheme is estimated to be about \$2,100,000.

### Suggested Removal of Bridge at Amsterdam.

The North Sea Canal, which connects the Port of Amsterdam with the sea 16 miles away, is being widened to 100 metres (328-ft.) and deepened to 15 metres (49-ft.). The two railroad bridges at Hembrug and Velsen which span the canal have, for a long time past, been considered a serious impediment to navigation, and proposals have been made to have them removed. A scheme is now being examined by the Authorities for the removal of the Velsen bridge and its replacement by a tunnel. It is estimated the work would cost about 10,000,000 guilders.

### Port of Dublin Improvements.

Dublin Port and Docks Board is promoting a private Bill in the Dail to carry out a number of improvements. The text of the Bill proposes to empower the Board to raise £870,000 by borrowing or by the issue of stock. Among the improvements contemplated are the following:—Reconstruction of Custom House Quay, £150,000; development of Custom House Docks area, £200,000; reconstruction of graving slips, £25,000; reclamation of land at Alexandra Basin, £120,000; improvement of Alexandra Basin, £285,000; provision of dredging plant, £90,000. The Bill also proposes to make provision in regard to officers of the Board and their superannuation.

### Pier Repairs at Galveston, U.S.A.

Piers No. 11 and 12, two of the oldest piers owned by the Galveston Wharf Company, which have been undergoing extensive repairs since last summer, are expected to be completed almost immediately. The T-heads of both piers have had their old bulk-heads renewed with heavily reinforced concrete piles, 15 to 16-in. sq. and 65-ft. in length. The apron of Pier 12, which has been extended to 27-ft. in width, is built over concrete piles 55-ft. long, and is protected by a timber fender system. On the apron floor, constructed of concrete, is a marginal track extending the full length of the warehouse, 900-ft. The warehouse, of frame construction, is being reconditioned and widened 35-ft. to a total width of 130-ft., and will be completed with a floor of brick and concrete.

### Modern Navigation on the St. Lawrence.

As a result of work completed recently on the St. Lawrence River by the Canadian Hydrographic Service of the Department of Mines and Resources, Ottawa, shipping on this major highway for ocean vessels from the Strait of Belle Isle to Quebec City, a distance of 878 miles, is now provided with a combination of facilities that make it one of the world's best protected navigation routes. Safe passage is provided by a series of 34 coastal and harbour charts, and these are linked with other aids to navigation, such as lighthouses and lightships, buoys and beacons, fog alarm and storm warning signal stations, the latest acquisitions being radio beacons and wireless direction finding equipment. Ocean liners of as much as 42,000 tons and 33-ft. draught now pass through the St. Lawrence at a speed never contemplated in earlier times.

## Reclamation of Tidal Lands by means of Dredged Spoil

By HERBERT CHATLEY, D.Sc. (Eng.), M. Inst. C.E.

The most satisfactory means of disposing of dredged material is to use it for raising low areas. In the best cases this serves some or all of the following purposes:—

- (a) Creation of land values.
- (b) Reduction of haul from dredging cut to dump.
- (c) Improvement of channels by concentration of stream.
- (d) Avoidance of bed accretion at dumping area.
- (e) Avoidance of marine risks to dumping plant.

On the other side of the picture are the following objections, some or all of which may arise:—

- (a) Excess of filling costs over market value of land.
- (b) Large capital investment in containing walls or dry transport plant.
- (c) Reduction of tidal magazine.
- (d) Obstruction of channel by shore-discharging plant and vessels transporting spoil.
- (e) Disturbance of land drainage.
- (f) Legal questions as to title or easements, shore access and boundaries.
- (g) Loss or reduction of foreshore use and shore access during reclamation.
- (h) Reduction of berthage for lighters and sailing boats and annulment of fishing rights.
- (i) Deflection of tidal currents by corners of reclamation.
- (j) Temporary and limited character of the method.
- (k) Slow consolidation of filled area and consequent delay of use.
- (l) Danger of injury of channel by failure of retaining walls.

### Economic Aspects

As in most engineering problems, the decisive question is an economic one. The pros and cons under this head are mainly as follows:—

#### Pros:—

Increase of land value.  
Reduction of haul.

#### Cons:—

Costs of containing walls and pumping plant or dry transport plant.  
Costs of shore protection.  
Cost of pumping over that of dumping.

It should be remarked that the work may be done in two ways:—

- (a) Dumping (so far as water levels will allow) and deposition of "dry" material.
- (b) Pumping of liquefied material into watertight basins from which the excess water escapes over a weir.

The "dry" process is usually an expensive one, as the plant must "dredge" the material from the containers which have transported it, and then carry it by telfers, belt or bucket conveyors, tipping trucks, or the like, all over the site. If the site is in deep water some filling can be done by dumping, but in such cases a front wall will be required to retain the material, unless it is sufficiently coarse not to flow or wash away.

The liquefaction process is usual with alluvial materials, but the cost of the enclosing banks is a difficulty. To keep this down the basins must be large, which means a good deal of pipe work. Experience seems to show that such pumping within, say one mile of the pump, can be carried out for about 6d. per cu. yd. of *in situ* material, not including the retaining walls.

The cost of the retaining walls depends on the length, height, relation to water level, foundations and the exposure to weather. Provided suitable material for them exists nearby (often in the foreshore itself), such banks, above L.W. level, may perhaps be constructed at 6d. per cu. yd. (*in situ*) of the spoil contained in the basin (not the cu. yds. in the banks themselves).

If now the cost of haul is, say,  $\frac{3}{4}$ d. per cu. yd. (*in situ*) of spoil per sea mile carried, this total of 1s. per cu. yd. will offset 16 sea miles of haul.

Thus if a foreshore of, say 300 acres, or say 1,500,000 sq. yds. is filled to an average of 3 yds. deep, it will take 4,500,000 cu. yds. of spoil. The retaining banks (including two cross walls and small banks at the back to prevent over-running the high land) may consist of, say, 10,000 yds. run of bank of an average sectional area of, say, 25 sq. yds., making a yardage in the banks of 250,000 cu. yds. Using the figure

of 6d. per cu. yd. of basin content (4,500,000 cu. yds.), we have £112,500, or nearly 10s. per cu. yd. of bank, which should amply suffice to cover the work, including protection. If the banks are in deep water, the costs will be much higher.

As to the effect on land values, the gross cost of reclamation per acre is high, and it will rarely happen that, unless regard is had to savings in dredging costs, it can be borne. Thus in the above case, if the cost of pumping and dykework is 1s. per cu. yd. of basin content, and the fill is 3 yds. deep, the cost is 3s. per sq. yd. of reclamation, or £726 per acre. This is obviously the main reason why such reclamation is not popular, but in many cases this cost is less than that of the extra haul to a dump. Thus if the cost of haul saved is deducted and this haul is 24 sea miles = 1s. 6d. per cu. yd., there is a saving of 6d. per cu. yd., plus the increased market value of the land.

### Tidal Effects

The reclamation of a tidal foreshore may or may not be harmful to the hydraulic regime of the waterway. In so far as the volume occupied by the reclamation is between ordinary spring high and low-water levels, the storage capacity for tidal water is reduced, and the incoming tidal flux up to the reclamation tends to be lessened by this amount. On the other hand, the narrowing of the waterway causes a concentration of the tidal stream, so that as long as the reclamation is kept behind proper training lines the reduced volume may still be



Shore Pumping Plant, showing flexible pipe joint  
(Lunghua Reclamation, Shanghai)

compatible with the pre-existing water levels and proper channel flushing. In river regulation it is often found, in fact, that reclamation carried out to the proper lines may not actually reduce the tidal flux, by reason of the better flow conditions (e.g., diminution of eddy losses at curves and shallows), so that tidal range is increased and flushing improved.

### Land Values

A highly paradoxical state of things exists in England in regard to land. Unless it has potential industrial value there is very little demand for it, and, in fact, large areas have gone out of cultivation and are laying practically idle. This is doubtless to be associated with the dangerous degree to which England has developed its manufactures for export so that the majority of the population is dependent on agricultural imports. This situation will doubtless change, but in the meantime it seriously affects the value of reclamation for agricultural purposes. It is, in any case, true that the cost of enclosing works and spoil pumping per acre is generally much greater than the agricultural value of the land, so that unless these costs can be recouped by economies in haul, the proposition is not attractive. The question of water levels is rather important. The dyking in of the foreshores (without filling) enables natural or artificial irrigation of the land to be readily controlled, so that the meadows of the Thames Estuary or the paddy fields of Chinese rivers are not improved for agriculture by filling.

The situation is quite otherwise if the land is in demand for industrial or shipping purposes, and it may even happen in such case that the rentals or sale price will fully recoup the reclamation costs.

Associated with this question are the time of solidification and the nature of the soil.

### Consolidation and Nature of the Soil

In the process of filling by the liquid process there is a sorting out of the finer particles, which run away at the discharge weirs with the excess water, so that if the spoil is of a sandy nature it quickly settles, providing a good foundation in a short time. If such fill is to be used for agriculture it may be possible to arrange for the surface fill to be of a fertile material.

## Reclamation of Tidal Lands by means of Dredged Spoil—continued

Where the material dredged is largely of a clay-like character or contains organic humus, the problem is not so simple. While perhaps 10% or so of the material may run off as colloidal particles with the excess water, an appreciable amount of the fine stuff remains, and all the particles are so small that the squeezing out of the water under the weight of the filling material is a slow process. Terzaghi and Frohlich have shown that consolidation of thick layers of alluvium may take thousands of years, and Casagrande has shown that condensed artificial slurries may have much less solidity than slowly-formed natural alluvium owing to the formation of special grain structure in the latter. In the Whangpoo River at Shanghai, where some square miles of reclamation have been made by liquid filling, it is generally found that the surface of such fill has a crust of about 1-ft. in thickness a year after filling, increasing by about 1-ft. per annum, so that while it can bear moderate surface loads within two years, structural foundations must be carried on piles down into the natural material below. The speed of consolidation can be increased by the use of land drains or by the use of small quantities of flocculants, such as alum.

### Filling Levels

There is a strong temptation to the engineer in charge of spoil disposal to raise the filling to a high level so as to concentrate the maximum quantity of spoil on to a given area. This may be very disadvantageous in respect to the subsequent use of the land. Even from an agricultural point of view, it has objections, since such land will perhaps dry out too quickly. For industrial or shipping purposes, the finished level at the water's edge certainly should not be more than, say, 1 or 2 feet above extraordinary high-water level, as otherwise great effort will be required to raise goods from water level to the ground. If the reclamation is large, there is no objection to the parts remote from the water's edge being raised several feet above the extraordinary high-water level, with a gentle slope towards the water's edge. How far this is practicable depends on the pressure of the spoil pump.

### Construction of Retaining Walls

Since the major part of the cost of reclamation is in the building of the watertight containing walls, every effort must be made to utilise economical methods of construction for them. Should it be intended that the front wall is to be used for shipping purposes, naturally forms, including sheet piling, with anchor plates and rods, masonry or concrete walling may be considered, but from the reclamation point of view, these are not to be compared in cost with simple dykes, and are not correctly chargeable in their entirety against the cost of reclamation.

On a mud or sand formation, with a brushwood mattress foundation up to ordinary spring low water, and a rubble stone toe dyke up to, say, neap low water, a clay bank will generally serve, unless the spring tidal range is over, say, 20-ft. For somewhat greater ranges the stability can be increased by enlarging the toe dyke, flattening the slopes or inserting berms, and if necessary, incorporating some gravel or ashes in the banking material. A good practice is to make the front slope 1 in 2, and the back slope, say, 1 in 3, with a 3-ft. top.

The front slope is protected during the work with a layer of reeds, held down by brushwood ropes pinned into the dyke with stakes, and covered with rubble. After the filling is complete and the dyke fully settled, this is stripped and replaced with carefully hand-packed rubble on sand, or a cemented stone pavement of hammer squared stone.

The dyke is raised to about 1½-ft. above the filling level to allow for settlement and surging in the basin. Thus, if the dyke is 20-ft. high, built on a fairly level bottom at spring low water, a 30-ft. mattress, 2-ft. thick, under the front edge, with a stone toe dyke up to 5-ft. above spring low water, the quantities and cost are somewhat as follows, per foot:—

	£	s.	d.
1,060 cu. ft. of earth = say, 40 cu. yds. at, say, 2s. ....	4	0	0
36 cu. ft. or rubble stone for toe dyke = 1½ tons at, say, £1	1	10	0
30 sq. ft. of mattress, 3-ft. thick, consolidated to 2-ft. =			
3½ sq. yds. at, say, 12s. ....	2	0	0
Temporary protection.—33 sq. ft. = 3½ sq. yds. at, say,			
10s. 6d., say ....	2	0	0
Permanent protection.—33 sq. ft. = 3½ sq. yds., at, say, 30s.	5	10	0
	£15	0	0
Supervision, etc. ....	5	0	0
	£20	0	0

(Bank volume being 40 cu. yds., this equals 10s. per cu. yd., as given before).

The lateral, rear and partition dykes will be less expensive, being of smaller average height and needing less protection. The excess water is run out through pipes built through the dykes and entering timber sump boxes, having on one side an adjustable weir. The pipe line is carried on rough trestles on light temporary piling. At the junction with the spoil pump, a

strong platform is required to carry the telescopic swinging joint required to allow for the tidal rise and fall of the pump, with heavy temporary guide piles for the pump.

The getting of suitable clay for the dykes sometimes presents difficulties, as economy requires the haul should be a minimum. In some cases light temporary dykes can be put up on the fore-



Completed filling (Quay wall being built outside)  
(Jukong Wharf, Shanghai).

shore, made with the foreshore material, and the bank material procured from the borrow pits so enclosed. Light runways on trestles are then used to carry the material to the actual bank site. Alternatively or supplementarily, the material may be carried to the site by boat at high water and dumped.

## Pilotage Conference

At the annual Conference of the United Kingdom Pilots' Association, held in Newcastle in mid-June, various topics were discussed which have a bearing more or less direct on port affairs. Among them was the question of the assessment of pilotage rates on which the following remarks were made in the annual report of Sir John Inskip, the Secretary and Solicitor of the Association.

### Assessment of Pilotage Rates

"The proper basis of charge for the assessment of pilotage rates has often been a matter for discussion, but it is now exercising the minds of pilots to a greater extent than ever before, owing to the modern trend of shipbuilding. It is well known that shipowners resort to all manner of devices with a view to reducing the net tonnage of their vessels. When first pilotage charges were based on footage alone, this development was never foreseen, and to-day vessels of comparatively light draught are carrying cargoes which make the continuance of a footage charge alone a very unfair one. A gradual change from footage to tonnage and footage, is taking place, and we frequently find a charge based on both tonnage and footage, which is perhaps the fairer method if some allowance is to be made for the ballast or partly loaded vessel, although even on that point there is plenty of room for a difference of opinion as to whether a vessel in ballast should be piloted for a less charge than a laden vessel, which is admittedly easier to handle.

"It is obviously desirable that, as far as possible, the burden of maintaining a pilotage service should be borne equally. It is not, however, always simple to effect a change, because it is invariably found that a departure from footage to tonnage, or from footage to a combined tonnage and footage rate, must cause an increase in pilotage rates to those shipowners who have been allowed to benefit by the continuance of some anomaly, but in fact the removal of anomalies of this kind should not be regarded as a hardship."

### Compulsory Pilotage

The subject of compulsory pilotage was also raised, and several delegates condemned the "one-way system" which obtained at certain ports. "Pilots were compelled to keep the pilot stations and to offer their services, but the pilots could not compel masters to take pilot services. On dirty weather nights some masters burned blue lights and sounded sirens in their anxiety for a pilot to take them in. If weather was good when they went outwards, then they did not want the pilotage service." Sir John Inskip, in defining the legal position, said "there was only one way to secure a remedy, and that was by an alteration to the Pilotage Act in a material way. It would mean pulling the Act to pieces. A pilot was compelled to offer his services to a ship."

At the election of officers, Lord Apsley was unanimously re-elected President of the Association.



Berths 4 and 5 from Tug

## The Port of Beira

### Notes on the Progress of Recent Extensions

Since the appearance of the article on the Port of Beira, in the issue for April, 1937, of this Journal, energetic measures have been taken for the extension of the berthage at the deep water wharf by an additional 1,200-ft., which when completed will provide a total available frontage of about 2,800-ft., sufficient for the accommodation of five vessels of the larger type visiting the port, or of a greater number of small vessels.

Good progress has been made with the work by the contractors, Messrs. Pauling & Co., Ltd., and the first additional berth is now at the point of completion, while the second berth is well advanced.

The type of construction adopted is the same as that used in previous berths, and consists of a foundation of cast-iron cylinder piers, 3-ft. in diameter, with 7-ft. diameter screws sunk through mud to a depth at which they will carry the requisite loads. On these cylinders, which are shown in illustrations on this and the following page, there are carried deep open girders on which rests pressed steel troughing filled with concrete. A detailed description of this work was given in our issue for April, 1933, and general views of the extension are given in the photographs in this issue, which have been courteously furnished by Messrs. C. S. Meik & Halcrow, the Consulting Engineers of the Companhia do Porto da Beira and Beira Works, Limited, who control the undertaking.

A novel feature of the present construction is that Braithwaite and Company's cylinder-screwing capstan is prevented from rotating by a temporary framework, and the use of anchoring guy ropes is therefore dispensed with. The arrangement works

satisfactorily, and as many as eight cylinders have been sunk in one week.

After the cylinders have been sunk to the required depth, they are pumped out by means of a semi-rotary pump, as shown in the photograph below, prior to being filled with concrete. On completion, the cylinder-bearing capacity is tested by a proof load of 125 tons, in the manner indicated by the succeeding photograph.

The bank of the river is dredged to the requisite slope in advance of the cylinder construction, and as soon as the cylinders have been placed in position, the slope is protected with a layer of 3-ft. of rubble stone. The rubble extends in front of the face line of the wharf to a distance of about 20-ft., with a thickness of 6-ft., so that in the event of holes being scoured in the river bed opposite the wharf, the stone adjusts itself to the new slope and forms a protection. Experience with existing berths shows that this method of protection is proving satisfactory.

Simultaneously with the construction of the wharf frontage, the erection of two transit sheds is proceeding in the rear. The first of these sheds, which are each 300-ft. long by 75-ft. wide, is completed and practically ready for use, while the foundations for the second shed have been laid. The foundations consist of driven piles, 60-ft. long, at 8-ft. 6-in. by 7-ft. 6-in. centres. On the piles, there is a system of joists carrying steel troughing which, when filled with concrete, forms the floor of the sheds. The sheds consist of a steel framework with galvanised iron sides and corrugated asbestos sheeting on the roof. On the land side of the sheds there is a lean-to, which covers a loading platform and one railway track.

Reclamation work behind the wharves is in hand, and a comprehensive system of railway tracks is being laid on the area now ready for service. In addition, a 40-ft. road for motor



Pumping out Cylinder prior to depositing concrete (semi-rotary pump)



Load Test No. 4. Total load 125 tons

*Port of Beira—continued*

Berths 4 and 5. View from Wharf Crane



South end of Berth 4. View from Wharf Crane

traffic is being provided on the reclamation, parallel to and behind the wharves. The illustration below shows the foundation work for the sheds under construction, and the reclamation and rail track work behind.

The new berths are being equipped with ten portal level-luffing cranes, supplied by Stothert & Pitt, Limited. Six of these are of 3-tons capacity and four of 6-tons capacity. When these ten cranes are erected, the total number provided for the Beira deep-water wharves will be twenty-four. Electric capstans and fairleads are provided for wagon-haulage on the wharves. These are of the "Hillairet" type. The electric generating station of the port, which supplies current for its operation, is being enlarged to double potentiality by the installation of two Diesel generating sets, each of 200 kW. capacity. One of the new sets is in use, and the second is in course of erection. These generating sets are supplied by Mirrlees, Bickerton & Day, Ltd.

Final arrangements are in hand for the improvement of the entrance channels to the port. At present, vessels are unable to enter or leave the port at high water neap tides, and are occasionally delayed for a few days. The existing depths are to be increased so that vessels drawing 28-ft. of water may enter

the port on any high tide. These improvements will involve the dredging of about 1,000,000 cu. yds. of material.

The business of the port expanded rapidly up to the end of 1937, when the traffic handled at the wharves reached a figure of over 1,500,000 tons. Since then, however, there has been a falling off of trade, due to the general world unrest, and the traffic figures for 1938 are lower.

With the increase in traffic, it has been found necessary to provide an additional tug, which is now being built by Messrs. Cochrane & Sons, Limited, of Selby. The tug, which is of the twin screw type, with engines developing 1,000 h.p., will have a length between perpendiculars of 105-ft., breadth moulded of 26-ft. 6-in., and depth moulded of 13-ft., with a speed of 10 knots. The vessel is being fitted with fire-fighting and salvage equipment, consisting of two Messrs. Merryweather's improved "Greenwich Gem" pattern double cylinder vertical fire pumps, which have a capacity of from 900 to 1,100 gallons of water per minute, and which are capable of throwing a single 1½-in. diameter jet to a height of 190-ft. In addition, the vessel is being provided with a searchlight and the necessary fittings for wireless and a "Husun" Echo Sounding gear.



Wharf Widening behind Berths 1 and 2

## West African Groundnut Trade\*

### Loading Arrangements

The loading of groundnuts is effected at all places in the following manner, as regards groundnuts in shell.

They are shovelled from the large piles in the storage yards (called "seccos") and put into bags containing about 50 kg. Thereafter, the bags are weighed and brought on board. A kind of gangway, called "rance," is erected between the vessel and the quay serving as a passage for the labourers. After having emptied the bags, which they carry on their heads, by dropping the contents into the hold, they return to the "secco" with the empty bag and immediately obtain a full one, and so on.

When the arrival of the vessel is advised, an "avance" is made, i.e., a certain number of bags are filled in advance so that loading can commence at the normal loading rate as soon as the vessel is ready to receive.

In case of loading in the roads, the nuts, as stated in the section "Petite Côte," are delivered "sous palan," alongside, by means of barges.

The trimmers on board the vessel level the nuts in the holds.

### Mechanical Loading Appliances

Some years ago, several trials were made at Dakar to load nuts by means of mechanical apparatus. The procedure was the same as that employed for loading or discharging grain cargoes by pneumatic elevators; however, the groundnuts in shell being lighter than grain, were sucked up and thrown out too violently, and it was necessary to abandon this system.

Later, another method was introduced: the old-time bucket elevator. The nuts were taken from the piles by small buckets affixed to a rolling band without end, working on the same principle as ordinary dredgers. The buckets were emptied into a vertical chute and through it into the vessel. The installation was worked by motor. It is still used occasionally. However, it has not given any encouraging results, partly because the price of native labour is so cheap that it can easily compete with the mechanical system; in fact, by employing this apparatus the loading rate is about 40 tons per hour, or 400 tons in 10 hours, a quantity which is attained without difficulty in normal circumstances by the natives; and partly because all engines and machinery very soon deteriorate in the Colony and demand a strict survey and maintenance, not always easy to ensure, particularly if sand adheres to the nuts thus forming a dust which corrodes the machinery.

Finally, by the installation of mechanical loading appliances great unemployment would be created. In this connection it must be remembered that a large part of the native labour is formed by native farmers, who during the dry period get their livelihood from the stevedoring work.

At the present time, there is only one exporter who possesses mechanical devices; all the same, they are not used to any great extent. It is foreseen that one day a mechanical system giving full satisfaction will be invented, and the natives thus being superfluous, so far as stevedoring work is concerned, will be employed, for instance, in cultivating the soil, as Senegal has not yet reached its full possibilities of production.

The Port of Dakar possesses big storage yards, and a special harbour with two piers for the loading of groundnuts.

Two sheds can receive each 12,500 tons; one of them is completely covered so as to enable the reception of nuts during the rainy season.

As these sheds are situated at a rather long distance from the piers, it has been proposed to establish twin conveyor belts, and in this manner convey the nuts to the loading places, where they could be brought on board by the labourers; or, in case of nuts in bulk, be dumped from the conveyor belt into spouts or chutes leading the cargo into the holds of the vessel.

It has been stated above that the nuts are put on board by labourers who, standing on the deck, empty the bags into the holds. As the charter-party stipulates for shippers to bring the cargo alongside only, the shippers debit owners with a tax called "mise à bord" (putting on board), which varies at the different loading places, but as a general rule amounts to frs. 1.—per ton of cargo.

At Ziguinchor, this tax is called "Taxe de rance et de quai." Certain firms charge frs. 1.—per ton cargo, while others, as it would appear, charge frs. 1.50.

The shippers justify this charge by explaining that its revenue is intended to cover the maintenance and depreciation of the wharves and gangways which are the property of the shippers.

At some places, for instance Foundiougne, the gangway tax ("Taxe de rance") is debited separately, and amounts to frs. 0.25 per ton cargo.

### Daily Loading Quantity

After having seen the manner in which the loading is performed, it is easy to understand that the loading rate is dependent on the number of labourers employed; it is obvious that this number cannot exceed a certain limit without lessening the output of the labourers. However, it is a fact that at loading places where the vessel is lying close to the shore, a loading rate of 400 tons per day is a minimum, which is easily reached. The shippers admit openly that it is possible for them to load up to 800 tons per day, but that they are not interested in doing so in view of the conditions of the charter.

When making use of mechanical loading apparatus, the loading rate amounts to 40 tons per hour, i.e., 400 tons per apparatus per day. It should thus be possible to load a vessel in 24 hours. The same result can be obtained, at Dakar and Kaolack, by employing a sufficient number of labourers; although this result has seldom been achieved.

## The Use of Treated Timber in Marine Terminal Construction\*

By GEORGE T. TREADWELL, Port of Seattle, Seattle, Washington

The protection of timber in salt water against the attack of marine borers has been attempted by many methods since the earliest historic times. Probably the earliest attempts were those of the Phoenicians and Trojans who sheathed their galleys with lead in an attempt to stop the destructive work of the teredo, or the ship worm, as it is most commonly called. Many methods of preserving timber and piling have been developed since the days of the ancient Phoenicians, most of which have been unsuccessful from the standpoint of permanence, although very interesting.

Since the year 1912 the Port of Seattle has been using treated timber and piling in its various structures on Elliott Bay and as a result has had the opportunity to observe the action by marine borers and wood-destroying fungi. For the purpose of this paper a brief description of the type of treatment, together with any record data on the particular installation, will be listed.

In the use of treated timber and piling we have had far more experience with pressure-treated creosote than any other treatment. Since 1912 there have been over one million five hundred thousand lineal feet of creosote pressure-treated Douglas fir piling driven under the municipal docks. Practically all the piling used by the Port of Seattle calls for a full-cell pressure creosote treatment and our specifications require the retention of twelve pounds of black oil per cubic foot of timber and a minimum penetration of three-quarters-of-an-inch. The following table shows the location and amount of piling driven, together with a few brief remarks as to their condition:—

### PORT OF SEATTLE CREOSOTE BEARING PILING DATA.

Pier	Year Installed	Lin. Ft. Driven	Remarks
Pier 41	1919	269,000	12,000 lin. ft. replacements to date. Piling in fair condition.
Pier 40	1913	181,600	Inspected 1930, 4% bad. Estimate 10,000 lin. ft. replacements to date.
Bell St.	1913	228,993	Inspection 1928, less than 5% bad. 3,000 lin. ft. replacements to date.
Lenora St. "B"	1918	81,000	Inspected 1930, none classified as bad.
Lenora St. "A"	1915 & 1930	104,500	Majority of old piles—fair.
Connecticut St.	1918	111,855	Piling now being salvaged and re-used. Excellent condition.
Stacy St.	1915	104,780	No replacements to date.
Lander St.	1915	91,200	Good condition—no replacements.
Hanford St.	1914	236,400	No replacements to date.
Spokane St.	1914-16	177,500	Good condition—no replacements.
		1,586,828	

NOTE.—Piling driven at Pier 40 in 1913 were salvaged in 1930 and re-driven at Lenora St. 85% were in good condition.

One thing of interest in the above table, not apparent unless one is familiar with the location of the port piers, is that at the three south end terminals, Spokane St., Hanford St., and Stacy-Lander Sts., while they are as old as the others, there have been no replacements of piling to date. These terminals are located on the east waterway which is fed by the Duwamish River. Probably the relatively large amount of fresh water that comes down the river accounts for the lack of any serious marine attack on these piling.

Just recently we made an examination of the creosote piling located under the west end of Spokane Street Dock which were driven in 1916. We did not employ a diver for this work as

\* Extracted from the April-May 1939 Circular of the Baltic and International Maritime Conference.

\* Reproduced from the Proceedings of the 25th Annual Convention of the Pacific Coast Association of Port Authorities, 1938.

### The Use of Treated Timber in Marine Terminal Construction—continued

most of the piling were exposed at extreme low water. No evidence of marine borer attack of any kind could be observed and very little decay was discovered in the head of the piling. Thus, after twenty-two years of service, we decided to construct another building, using the existing piling for the foundation.

At the present time two samples of "Mineralised Cell" treatment of piling are in use as fender piles at Smith's Cove Terminal. At this terminal the Port of Seattle maintains jointly with the City of Seattle a marine testing laboratory. Unfortunately our last sample, which was a piece about five feet long, of "Mineralised Cell" was destroyed by someone—presumably boys breaking into the laboratory. However, there are many examples of this type of piling driven in Elliott Bay and soon a service record will be established for this type of treatment in our waters.

At the present time we have a four-foot sample of piling that has been given a pressure treatment of toxic chemicals known as "Chemonite." This sample has been in the laboratory a little over a year, and has not been attacked in any manner insofar as we are able to observe. There seems to be some leaching of the copper sulphate solution from the piling. Whether or not this is just a surface condition cannot be determined as yet.

The Port of Seattle has used a considerable amount of treated creosote timber and planking in bulkhead construction. One of the largest installations is at Pier 40. This bulkhead is of the Wakefield type in three thicknesses. The two outside thicknesses are pressure treated with creosote.

This bulkhead has been in service for the past twenty-five years, although during the past two years it has started to deteriorate rather rapidly, especially on the back, or filled side, near the top. Also there is a good deal of evidence of limnoria attack on the front side, especially along the beach line. The bulkhead can probably be maintained for a few years yet with reasonable maintenance before replacement will be necessary. By way of comparison, a bulkhead of similar construction (although untreated) was erected at Pier 41 in 1920, and by 1934 had to be completely replaced, thus at this location the creosote bulkhead at Pier 40 apparently will have at least twice the life of the untreated one.

At the Spokane and Handford St. Terminals the bulkheads were constructed of creosote lagging direct on the piling in a series of low steps. With the exception of the top step the lumber is wet practically at all times. Both of the bulkheads appear to be in very good condition to-day after nearly twenty-four years of service.

It has been the policy for many years to treat our own railroad ties. In the spring of each year we purchase about 60,000 feet B.M. of No. 1 select Douglas fir green ties. The ties are stacked out in the sun and left to weather till late summer in order that they will be thoroughly checked and seasoned. The ties are then dipped in or brush-treated with hot creosote. The creosote used for this purpose is in accordance with A.W.P.A. specifications for brush treatment. The tank is generally heated to a temperature of 150° F. Ties treated in this manner seem to give good service, and it is not unusual to find ties that have been in service fourteen years. Each tie as it is placed is marked with a tie dater and its age is very easily determined. The cost of treating ties in this manner as compared with untreated ties is as follows:—

Untreated Ties.			Brush-Creosote Treated Ties.		
Green ties, each	...	56c.	Green ties, each	...	56c.
Placing ties, each	...	40c.	Placing ties, each	...	40c.
	...	—	Brush-treatment, each	...	13c.
Total cost	...	96c.		...	—
Life 6-8 years—			Total cost	...	\$1.09
Cost per year per tie	...	14c.	Life 12-14 years—		
			Cost per year per tie	...	8½c.

Up to the present time the Port of Seattle has never completely constructed a pier or pier apron using 100% treated materials, but has used cross ties along the building line and quite a few caps in this location. We have had some experience with dip-treating wharf timbers, and the next example (which I cite with some little hesitancy because it may sound a little incredible) was the construction of the Spokane Street north apron. This apron was constructed in 1915, and all the sub-structure timbers, including the caps, track chords, ties and stringers, were dip-treated in an open tank, using carbolineum avenarius. This apron construction remained in constant use from 1915 to 1936, or twenty-one years, which seems an incredible life for that type of treatment. I do not believe I would recommend a treatment of that type for apron construction, but it is certainly evidence that some type of treatment for that portion of the dock that is not covered by the transit sheds is well justified, because as you all know, this problem of maintenance is indeed a problem, and any time you can save the complete labour charge on a renewal by using treated timber and lumber, such use is generally warranted.

At the present time the Port of Seattle is making studies and plans for two new piers, and if they materialise into actual

construction the timber and lumber which will be exposed to the open weather or tidal action will be thoroughly treated. Just what type of treatment we propose to use is not definitely decided.

#### Discussion

**President Averill:** Are there any questions that anyone wishes to ask Mr. Treadwell with reference to this paper?

**Mr. Nicholson:** Mr. Chairman, I was very much interested in Mr. Treadwell's paper. I was associated with the Port of Seattle from 1910 to the latter part of 1924. I am very much in favour of pressure-treated creosoted timber and piles, where it can be used. I think there is a place for Wolmanized lumber, too, for the reason that it is probably the most economical construction that can be used. There is one question I would like to ask Mr. Treadwell: What experience have you had in recent years with limnoria attacks?

You probably know down South, in Southern California, we have had considerable difficulty with limnoria attacks in fresh salt water. Of course, we have no trouble in the inner section of the harbour, due to the fact that the water is contaminated; but we have had very considerable difficulty with limnoria attacks in fresh salt water.

I inspected the sub-structure of the Long Beach harbour, the outside piers, a short time ago, about a year ago, and approximately 35% of the piles had been attacked by limnoria, and those piles had been in place, I would say, not over eight or nine years. And I recall about twenty years ago I inspected some piles on the central waterfront of Seattle, which were private piers—I am not speaking about public piers—and at that time the piles were pretty badly cut up by limnoria attacks. I am just wondering what experience you have had recently.

**Mr. Treadwell:** All I can say, Mr. Nicholson, the limnoria are still very active. As an example of that, we made a seal between the pre-cast concrete sub-section that we used and the steel piling. They used tongue and groove material to make that seal. In fourteen months the limnoria had completely eaten the seal away. They drove bark piles to support the overhang of the sidewalk area. Practically all those bark piles are now eaten away, and the work is essentially the work of limnoria. It is an attack at low tide—conforms to the hour glass.

Teredos are very active in those waters, too. It still does not pay to use untreated bark piling any place along the waterfront. Down at the south end terminals they seem to last quite some time. We drove piling for a track in the vicinity of Atlantic Street, which as you know, is practically the end of the waterfront, and they lasted four years. So you can readily see that the south end is more favourable for untreated piling.

**Mr. Nicholson:** I probably did not make myself clear. I had reference to creosote piling. And the piling I inspected along the central waterfront in Seattle were creosoted piling also. They had been in many years, were quite old. Presumably they had been attacked by limnoria. We have had some trouble in the southern ports.

**Mr. Treadwell:** We are having more trouble with creosoted piles with attacks of teredo than limnoria, except where there is chafing. The trouble is more with teredo than limnoria.

**Mr. H. W. Davies:** Mr. Chairman, it might be interesting to note that at Port Angeles when they built their dock, they built a dock 1,500-ft. long and about 200-ft. wide, and they thought at the time the piles were driven, on account of the liquor from the pulp mills, that would preserve the piles, so they built the dock all out of green piles, on the assumption that the liquor from the pulp mills would kill off the teredos. But to their sad experience, in less than three years they have had to replace the entire piles.

**Capt. Brennan:** What treatment do you recommend?

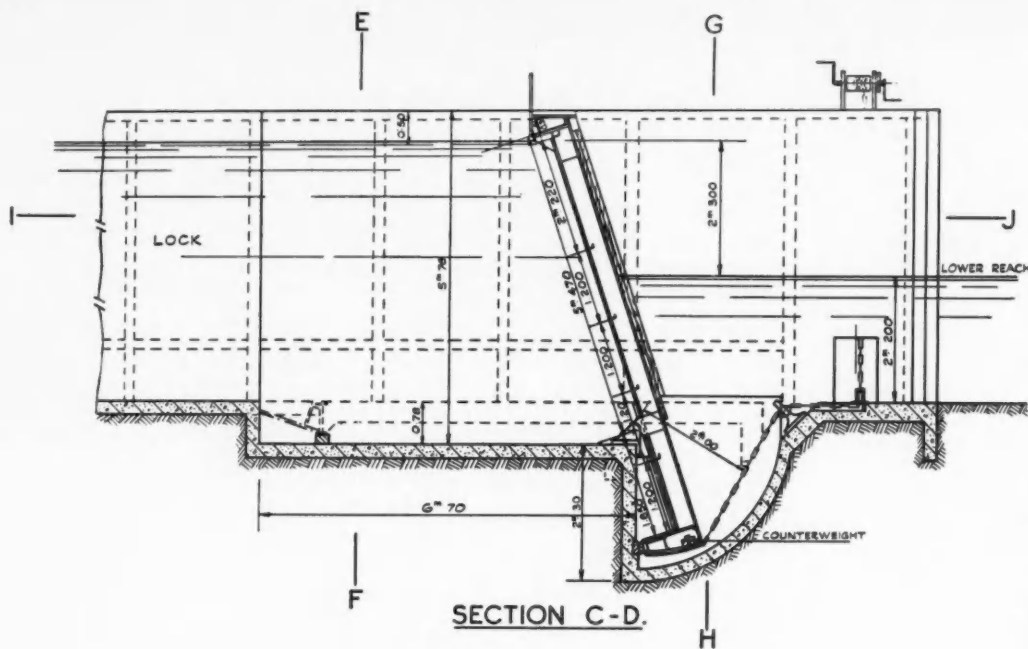
**Mr. Treadwell:** We have been using 12-pound treatment. I personally think it should be a little heavier.

**Capt. Brennan:** We use 14-pound; 14-pound lasts about ten years, 12-pound about seven or eight years.

**Mr. Nicholson:** In Southern California our specifications call for 16-pound treatment—that is, for fir; and for pine it calls for 24.

**Mr. Treadwell:** We have never used over 12 in Seattle on fir.

**Mr. Nicholson:** I think we have more severe conditions down South. I might say we have some piles in Los Angeles Harbour that are forty-three years old, still giving service. They were driven in the long wharf at Santa Monica in the early days, then brought down by the Southern Pacific and installed in the Southern Pacific wharf at San Pedro. Those piles are forty-seven or forty-eight years old. They don't look very good, but they are still there and doing service. However, as I say, we have no difficulty with creosote piling; in fact, I think it has a very long life, probably forty or fifty years in the near sections of the harbour where we have that contamination, but in the outer sections of the harbour we do have considerable difficulty with limnoria.



Plan No. 1. Preliminary Scheme for a Lock-Gate

## Tilting Lock Gate: Cherre System

By V. CHERRE, Civil Engineer of Roads and Bridges (France)\*

### Description

Lock gates usually consist of a pair of leaves turning upon vertical heelposts placed in the hollow-quoin recesses of the side walls, meeting at an angle in the centre of the opening, and shutting, at the same time, against the pointing sill at the bottom. This type of gates offers many advantages as well as some inconveniences, among which are the thrust on the side walls, difficulty in ensuring the complete closing of the leaves and watertightness along the meeting posts and the sill against which the gates abut.

In addition, during motion, when each leaf bears at the bottom on a steel pivot let into the heelpost stone, and is held against the hollow quoins, at the top by an anchorage encircling its head, there is a tendency for the leaves to drop at the outer end and to warp in their vertical plane.

Further, the pull of the machines or chains on the gates during motion may be applied to the upper part of the leaves, while the centre of gravity of the water resistance is at their lower part. From this there results a force couple, the effect of which is to produce torsion of the leaves.

In order to avoid these inconveniences another system of revolving lock gates may be employed without horizontal thrust on the side walls. In this system the water pressure is transmitted to the walls in the direction of their length by the gate,

Besides these ribs, the posts are tied at the bottom by a 10-in. channel, whose purpose is to support a counterpoise of cast iron blocks necessary for balancing the gate.

A skin of  $\frac{5}{16}$ -in. plates is riveted to the flanges of the posts and of the horizontal ribs.

At the top of the gate there is a lattice-girder sufficiently rigid to support the water pressure on the upper part of each intermediate post and to transmit it to the lock walls. Thus, the gate being closed the posts are held below by the hinges fixed in the gate floor, whilst above they are connected to the lattice-girder. In this manner the posts are in the condition of a simple beam overhanging one support.

Furnished with a wooden floor and metallic railing, this lattice girder is used at the same time as a foot-bridge.

To enable access to the hinges and for cleaning out the sediment which can deposit in the space under the lower part of the gate, a manhole is provided in the plate skin and closed with a cover.

Each post of the gate is provided with a male hinge of cast steel, riveted or bolted to it. A female hinge fixed in the floor receives the male hinge by means of a pin of  $2\frac{3}{8}$ -in. diameter. Each female hinge is fastened to the floor with two horizontal bolts, embedded in concrete and with two vertical bolts, whose diameters are respectively 2-in. and  $1\frac{1}{2}$ -in.

The load on the hinge, produced by the water pressure on the gate, is transmitted to the bolts by the cotters *A* and *B*, consisting of the actual cotters "*a*," two wedges "*b*," the piece "*c*" maintaining the distance between the wedges, and the stirrups "*d*" which are provided with screws, pushing the piece "*c*" close to the wedges "*b*." (See Plan No. 1).

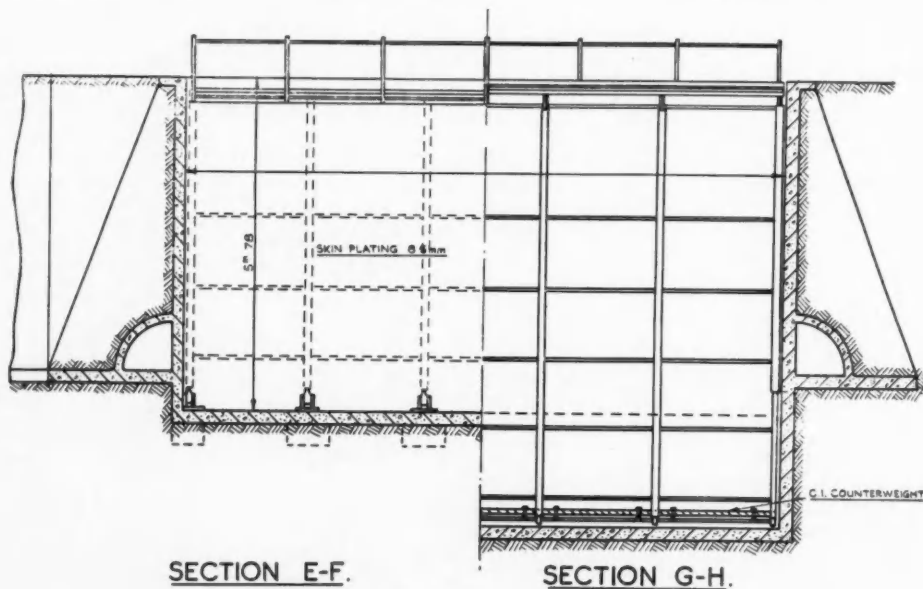
Horizontal bolts are laid during concreting the gate floor, whilst vertical bolts are placed when fastening the hinges. For this purpose, under each hinge a small compartment is provided,

allowing the introduction of washers and small cotters; vertical bolts are lowered through holes in the gate floor on both sides of the hinges.

The greater part of the water pressure on each intermediate post is transmitted to the floor by means of the hinge, whilst the remainder is taken by the upper lattice girder, which, bearing on the lock walls, is in the condition of a beam on two supports. Details of the lattice girder are given on Plan No. 2.

The lock gate being closed, the end posts bear on the 5-in. wide stops of the walls, provided with  $3\frac{1}{2}$ -in.  $\times$   $6\frac{1}{2}$ -in. wood lining. Similarly, the downstream flange of the upper part of each end post and the upstream flange of its lower part are fitted with  $3\frac{1}{2}$ -in.  $\times$  8-in. wood lining, assuring water-tightness.

The brackets at the bottom ends of the posts, provided with  $3\frac{1}{2}$ -in.  $\times$  10-in. wood-lining, bear on a longitudinal wooden piece fastened to the vertical wall of the gate floor.



SECTION E-F.

SECTION G-H.

Plan No. 1. Preliminary Scheme for a Lock-Gate

### *Tilting Lock Gate Cherre System (continued)*

In this manner the watertightness along the stops is assured, but an interval about 2-ft. 8-in. long is formed between the upper and lower stops of the lock walls, through which water can flow. In order to obstruct this interval, the wooden piece fixed on the lower part of each end post is prolonged upwards through a length of 2-ft. 8-in., and a slit between it and the masonry of walls is obstructed by an india-rubber strip of the same length, screwed to the wooden pieces.

In order to avoid leakage along the web of the end posts between the two wood-linings, a transverse 4-in. high wooden piece with an india-rubber strip is provided (see cross section *E* and *F*, Plan No. 2).

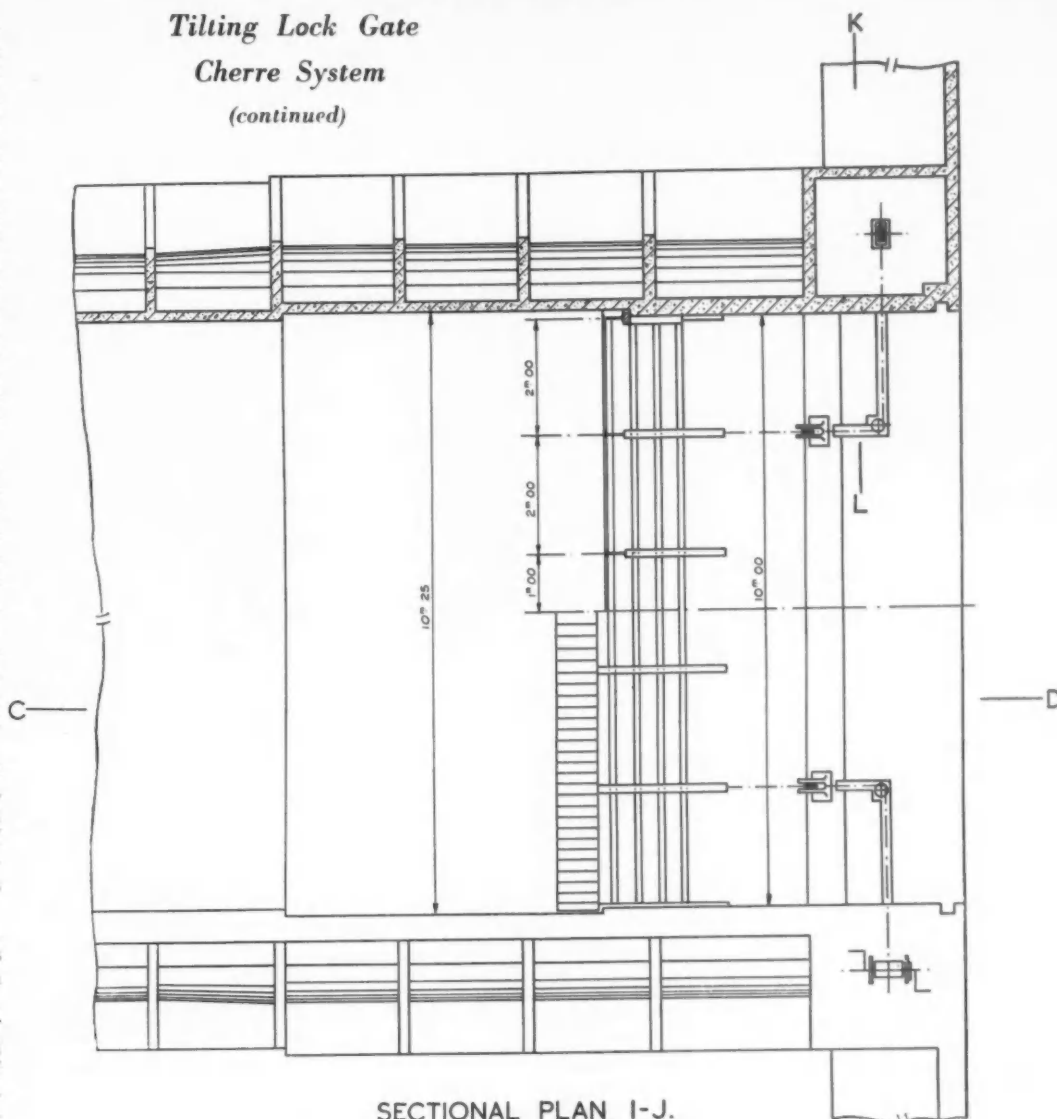
For changing these strips, it is necessary to arrange in the web of each end post a hole, closed with a cover.

The wood-linings are fastened to the end posts by means of bolts spaced every 1-ft. 8-in., and of channel pieces, riveted previously to the outer flanges of the posts.

When the gate is closed, the water pressure on its upper part is greater than that on its lower part, consequently the upper part of the gate is pushed against the projections of the lock walls and equilibrium is assured. The counterpoise fixed on the lower horizontal rib, contributes to the stability of the gate. For opening the gate, the water in the lock-chamber is to be brought to the same level as in the downstream reach; by two winches working on the side walls, a pull is produced on chains shackled to the lower brackets of the end posts, and the gate lies down on the gate floor. Thus, when the gate is opened, the chains are taut. The counterpoise is so chosen that the sum of its moment and of the moment of the weight of the lower part of the leaf with reference to the rotation axis is greater in any position of the gate than the moment of the weight of its upper part about the same axis; in this manner, if the chains are loosened, the gate closes itself automatically.

For directing the movements of the chains, guide pulleys with horizontal and vertical axis are fixed on the floor and in the shafts.

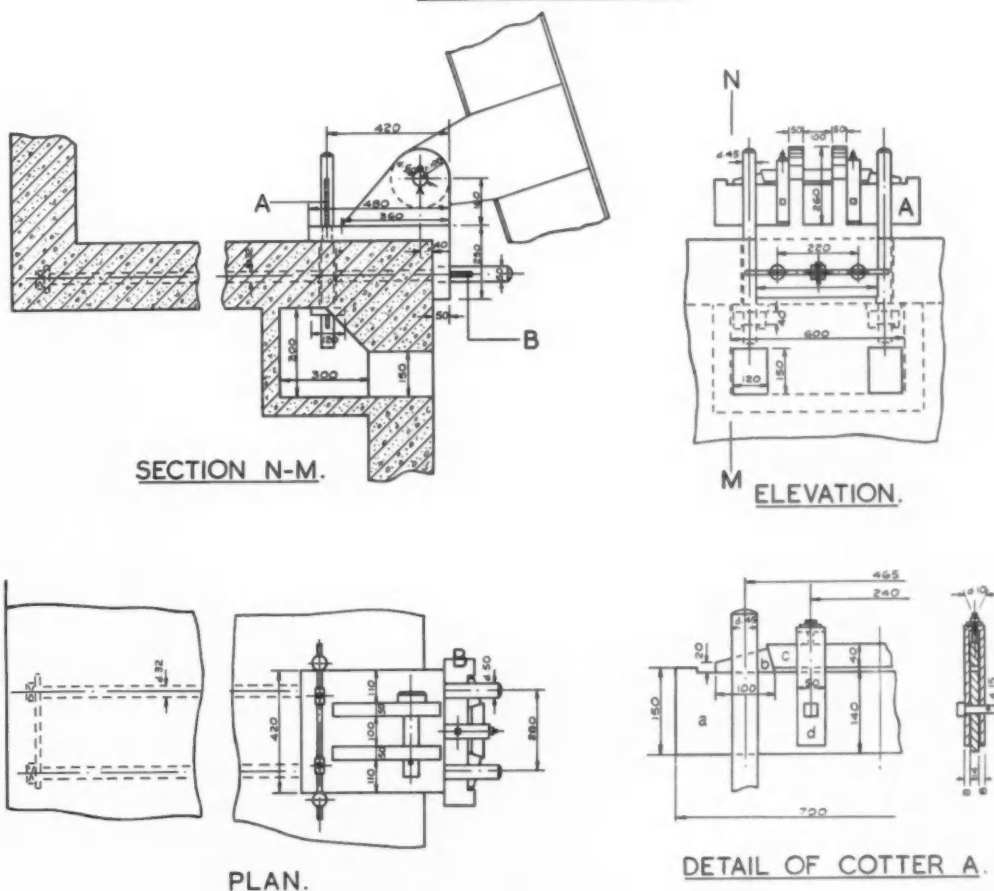
A particular feature of this system is that the floor contiguous to the gate has to withstand the greater part of the water pressure on the leaf. The gate being closed, the water



SECTIONAL PLAN I-J.

### Plan No. 1. Preliminary Scheme for a Lock-Gate

### DETAILS OF HINGE.



**PLAN.**

### Plan No. 1. Preliminary Scheme for a Lock-Gate



# Ship Slipways

## An Article for Students

By STANLEY C. BAILEY, Assoc. M. Inst. C.E., F.G.S.

### Early Slipways

**S**LIPWAYS for ships or slip docks, for raising vessels above high water level so that the exterior of the hulls may be repaired, scraped, and painted or tarred, were invented by Thomas Morton, of Leith, the first being constructed at Dundee in 1837. Slipways at that time were chiefly used by fishing vessels and consisted of an inclined plane or "hard" with two or three lines of railway from above high water level to low water mark, and the cast iron rails in 3-ft. lengths were either fixed direct to stone blocks, or to longitudinal baulks of timber, secured to the hard stone setts of the slipway.

The timber-built cradle to carry the ship was mounted on numerous cast-iron flanged wheels which travelled on the rails. The ship was floated over the cradle at the lower end of the slipway at high tide, and as the tide fell, it gradually rested on the cradle blocks, the bilge blocks and the arms carrying them, known as "cobs," being shaped to the bilge curves of the vessel, retained in an upright position. The cradle and ship were then drawn up out of the water by means of iron links about 2-ft. long, attached to the cradle at one end, and at the other to an iron chain in connection with a double purchase hand or team winch, or to a capstan worked by horses.

When about 48-ft. length of chain was hauled up, the four upper lengths of the links were removed, and the chain pulled down and connected to the links *in situ*. Similar slipways worked on this method are still in use for fishing boats and other small craft at various ports, but it is a slow process.

Previously vessels were either dry docked, or floated at high water over a level stone platform, or an inclined hard, prepared just above low water spring or neap tide levels, and as the tide fell, the ship was propped up; or else it was floated over a "grid" consisting of parallel longitudinal and cross timbers, with or without keel and bilge blocks, bolted down to the stone hard, or fixed to timber piles, just above low water neap tide level.

The repair work on the exterior of the ship was therefore tidal, and required to be rapidly done, but hards and grids were comparatively cheap, as little or no underwater work was involved in their construction, and they are still in use in many fishery ports.

### Modern Slipways

Most modern slipways are constructed so that the ship can be brought on the cradle at H.W.N.T. or H.W.S.T. levels, others are built so that the vessel can be lifted at all states of the tide. This involves the construction of the slipway well below L.W.S.T. level, which is expensive work, but must be faced in such situations as in ports on the coasts of the Mediterranean Sea, where the range of tide is only about 1-ft.

### Hydraulic Gear

With the introduction of hydraulic power by Lord Armstrong in 1849, for motive purposes, Daniel Miller in 1850 first used a horizontal hydraulic direct acting ram as the power for hauling up ships, and about the same period Messrs. S. H. Morton, of Leith, also adopted an hydraulic ram with a 10-ft. stroke, the water supplying the ram being pumped into a vertical accumulator by a steam engine and pump. The advantage of using hydraulic rams is that the efficiency of direct acting ones is from 85 to 90%.

The ram was fixed at the head of the slipway with its crosshead pointing up the slope, and from the crosshead a pair of parallel links or bars, joined together in 10-ft. lengths extended down the whole length of the slipway, one on each side of the central track rails, and bearing on flanged rollers at suitable intervals. The links were either circular or rectangular in cross section, and were connected together by a pair of joint plates with pins through them and the eye bar holes of the links.

Iron pawls pivoted to the cradle engaged with the links at the joints, and after each forward stroke of the ram, a 10-ft. length of each line of links was removed at the upper end by means of a small hand crane. The ram head was drawn back and re-connected to the lines of links ready for the next forward stroke. In the meantime the cradle was prevented from slipping back by pawls pivoted on it, which engaged with a continuous cast iron rack fixed at rail level on the slipway between the two centre rails, and extending the whole length of the slipway.

Generally, two or three parallel rams were used, attached to the same crosshead, according to the load to be lifted, including the weight of the links, and the friction of the cradle, links, and

machinery. Rams have been constructed with a 15-ft. stroke, the ram cylinders being 18-in. in diameter and weighing 17 tons each, while the weight of the rams was 5 tons each.

There are a number of slipways still in use worked on this system, but it is a slow method due to the slow motion of the rams, and the loss of time, averaging 8 minutes for disconnecting and reconnecting each set of links, while the average speed is from 3 to 4-ft. per min.

To overcome this difficulty Messrs. T. B. Lightfoot and J. Thompson employed a system of three parallel rams, the crosshead of which, carried in the middle, the piston of a fourth retaining or constant pressure ram, at the head of the parallel rams. From the crosshead, link bars extended on each side of the rams to another crosshead below the rams, from which two parallel lines of links in 10-ft. lengths, bearing on rollers, extended down the whole length of the slipway, one on each side of the two central rails, with a rack between.

The operation of the rams was as follows, viz.: water from the accumulator was forced into the main rams pushing them up, and driving the piston on the crosshead into the retaining ram cylinder. A hand lever in connection with the valves on the pipes from the accumulator to the main rams enabled the water to be cut off from them at the end of the stroke, and the rams were opened to exhaust, while the constant pressure on the smaller retaining ram forced the main rams downwards; so that by moving the lever backwards and forwards, an up and down motion was imparted to the rams and the links.

A number of iron pawls pivoted to the cradle engaged with the joints of the links, and so pulled the cradle up 10-ft. at each forward stroke, while pawls in the centre of the cradle engaged with the rack on the slipway, and prevented the cradle from sliding back between the strokes of the rams. A more or less continuous motion was thus obtained in hauling up the cradle.

Messrs. Hayward Tyler and Co. employed in their slipways, two independent rams, one on each side of the central rails of the slipway at its head, with a line of continuous iron links from each ram extending down the slipway. The rams were arranged to work alternately, so that while one ram was making an upward stroke, that of the other was downward. The cradle was thus drawn up continuously by means of the pawls engaging with the joints of the links.

When it is required to lower ships into the water, the pawls engaging with the rack and the links are knocked up or raised by means of levers, the cradle and ship thus move slowly down the slipway, the resistance of the water against the vessel increasing as she descends into the water thus gradually slowing up the motion.

### Haulage Power

The power required of hydraulic rams to haul a vessel of 3,000 tons plus the cradle of 100 tons and links weighing 40 tons, a total of 3,140 tons up a 600-ft. slipway on a gradient of 1 in 20 will be as follows:—

		3140	
Pull required	=	—	= 157.00 Tons
		20	
Friction of cradle and ship	=	3100	
		x 40 lbs.	= 55.35 "
Friction of links	=	40 x 20 lbs.	= 0.35 "
		212.70	"
Friction of rams	=	212.70 x 8%	= 17.01 "
Starting friction, and to overcome inertia	=	212.70 x 5%	= 10.63 "
		240.34	" say 240 tons

240 tons = 537,600 lbs., and allowing for a pressure of 700 lbs. per sq. in. on the rams, a total of 768 sq. ins. will be required, and if three rams are used, the area necessary will be 256 sq. ins. per ram, and as a ram 18-in. diam. = 254.4 sq. ins., this will meet the case. The actual pull on the links is 212.7 tons, and allowing 7 tons per sq. in. safe stress, then 30.4 sq. ins. will be required, and for two lines of links 15.2 sq. ins., therefore links 4-in. by 4-in. or 5-in. by 3-in. will suffice, and their weight will be about 60 lbs. per lin. ft., including joints for each line of links.

### Steam-Driven Slipway

In order to obtain greater speed in the working of ship slipways, Messrs. Day, Summers & Co. of Northam Ironworks, Southampton, patented in 1879, a slipway worked by a steam-driven winch, the barrel of which was grooved or scored to prevent the wire hauling rope between the cradle and the winch from riding on the drum. The steam engine had two cylinders, 10-in. diam. by 12-in. stroke, and a worm on the engine crankshaft, geared with a large worm wheel, on the shaft of which was a pinion 19-in. diam. which in turn geared with a spur wheel 10-ft. in diam., this was bolted to the winding drum. The hauling speed varied from 12 to 20-ft. per minute according to the load to be lifted.

## Ship Slipways—continued

### Electrically-Operated Slipway

In the Port of Dublin there is an electrically-operated slipway by Messrs. Day, Summers & Co., on a grade of 1 in 16, for ships up to 900 tons and cradle 100 tons. The machinery consists of an electric motor of 100 b.h.p. running at 750 r.p.m. which is supplied with current from the mains at 500 volts. The ratio of the gearing is about 4 to 1.

A worm on the shaft of the electric motor gears with a worm wheel on the shaft of which is mounted a pinion at each end, these pinions gear into large spur wheels that are bolted to two main drums on the same shaft, the drums having scored barrels. On the worm wheel shaft there are sliding clutches to throw the pinions in or out of gear, and on this shaft is the lowering drum, which is half the diameter of the winding drums, and can be worked independently, also on the shaft is a patent automatic friction clutch geared to the lowering drum which enables the latter to unwind the rope at the same speed as the main drums wind the hauling rope.

The rope from the lowering drum passes down to the lower end of the slipway round a fixed pulley block and then to the lower end of the cradle to which it is attached. The hauling speed is 10-ft. per min., and the downhaul speed up to 30-ft. per min.

In most of the modern slipways, this more expeditious method of hauling the cradle is adopted, and the machinery is either driven by steam, oil or petrol engines, or electric motors with worm gearing.

### Alternative Methods

Some slipways for steam trawlers and tug boats are worked on another principle, viz.: the cradle is hauled by means of a single line of iron eye-bars or links in 10-ft. lengths with pin joints. At the upper end of the slipway the end of the line of links is attached to gusset plates on an endless linked chain which passes round two horizontal sprocket wheels 2-ft. diam. and 15-ft. apart centres, lying parallel with the draw bar links, but to one side of the centre line, and just below the ground level.

The endless chain is operated by gearing in connection with a vertical 8-armed hand capstan, or by a horizontal steam engine. As the draw-bar links and cradle are hauled up, the 10-ft. length attached to the endless chain is removed, and the next length is fixed to another set of gusset plates which are 10-ft. away from the former on the endless chain.

The process is repeated until the cradle has been hauled up, but it is a slow procedure.

Slipways have also been constructed for loads up to 550 tons, where the power is applied by an hydraulic capstan. A block with double sheaves is fixed to the cradle, and another two sheave block at the head of the slipway is anchored to a concrete block in the ground. The steel wire rope passes round these sheaves and is conveyed round a capstan having a pull of 15 tons, from which it passes to a hand winch to take up slack rope, so that there is a 5-part tackle.

There are a few slipways in which runners in lieu of wheels are attached to the cradles, which travel on 3 or 4 lines of greased timber baulks anchored to the slipway, but the friction absorbed is twice as much as that for cradles carried on rollers.

The strains imposed on a vessel when being raised on a cradle are no worse than those due to launching or dry docking, or to the pitching of a ship in a heavy sea; and the risk of overturning in a gale when raised on the slipway is very small, there being a factor of safety of at least 20 under a wind pressure of 30 lbs. per sq. ft.

Most slipways are constructed in sheltered positions, sometimes alongside a jetty or pier for convenience in getting the vessel in alignment over the cradle, and when the slipway is sited normal to the current of a river, such training jetties are occasionally a necessity.

### Relieving Slipways

Slipways on which a ship can be hauled up and deposited at the head of the slipway, while the cradle is run down to raise another vessel are known as "Relieving Slipways," in one form of which the main longitudinal cradle carries another longitudinal cradle the wheels of which are placed normal to those of the main cradle and bear on a number of transverse rails on the main cradle. When the ship is hauled up, the upper cradle carrying the ship is pulled laterally off the lower cradle by steam or electric winches, on to parallel lines of rails clear of the slipway, and the main cradle is run down to take another ship. Sometimes a third cradle from the opposite side of the slipway is run on to the main cradle, so that three ships can be dealt with.

This type of slipway entails the upper portion being in a cutting with low retaining walls on each side, so that the lateral shore rails shall be close to and level with the transverse rails on the main cradle; the slipway also requires to be extended further into deep water than for a single cradle to obtain sufficient depth of water over the upper cradle.

Another method adopted when using two longitudinal cradles, is to haul up the cradles and vessel, and to run the top cradle and ship off to one side of the slipway. The ship is then blocked up with timber baulks and screw jacks between the framing of the

cradle, on a concrete platform. The cradle is then partially dismantled where necessary to clear the blocking-up timbers, run out from under the ship, re-erected, and run on to the main cradle ready to lift another vessel. This method is also occasionally used when there is only one longitudinal cradle, but the upper portion of the slipway requires to be lengthened so that the vessel may be deposited. The cradle travels on six lines of rails, two under each line of blocks, the upper cross beam and triangular framing of the cradle are removed, so that the cradle can be run down clear of the ship.

### Broadside Slipways

One other form of relieving slipway is known as "broadside slipping"; this method is adopted in cases where there are small tidal ranges, and to avoid building the slipways a considerable distance into the water. The cradle lies transversely with the line of the slipway, and is run down on numerous lines of rails, according to the length of the cradle and weight to be carried, but usually the rails are about 8-ft. apart, and the vessel is brought broadside on to the cradle. This method involves constructing the slipway wide enough to take the longest ships to be lifted, and additional racks, machinery, gearing and hauling ropes are necessary.

In some broadside slipways, the main cradle carries a longitudinal cradle with wheels placed normal to those on the main cradle, which run on three lines of rails laid on the latter. The upper cradle and ship are hauled laterally off the lower cradle at the head of the slipway, and the ship and cradle dealt with as already described.

With cradles of this type having a number of hauling ropes, it is difficult to obtain an even pull on all the ropes when new, unless the ropes have previously been equally strained, for one rope will stretch more than another, and the cradle being pulled more on one side than the other, will jamb on the rails, and the pawls will not engage with the ground racks in unison.

New steel wire ropes, unless previously strained, will stretch considerably; for instance: an 8-tons pull on a 2-in. diam. steel wire rope, 400-ft. long, with stretch it 2-ft., and a 16-tons pull will lengthen it by 3-ft. 6-in.

When ships of various lengths have to be raised by broadside slipping, and to avoid pulling up a long cradle for a short vessel, the cradle is arranged in sections which can be detached as necessary, and consists of a series of parallel trucks, each about the beam width of the ship in length; each travels on two lines of rails on the slipway, and has its own hauling rope and ground rack.

To synchronise the movements of the trucks, a steel shaft, having couplings between each truck is fixed right across the trucks at the lower ends on which is mounted gear and ratchet wheels engaging with pawls pivoted on the trucks. Each truck thus carries on each side two gear wheels, ratchet wheels, and pawls; the gear wheels engage with pinions on the shafts of the travelling wheels, thus uniformity of movement in all the trucks forming the cradle is obtained. To cut off any trucks, all that is necessary is to disconnect the cross shaft couplings of the end trucks.

Each truck carries keel and bilge blocks, and they are arranged fairly close together, so that there is no great length of the vessel unsupported. When a ship has been hauled up, it can be blocked up between the trucks, then wedges in the keel and bilge blocks of the cradle are knocked out, thus lowering them clear of the ship, so that the whole cradle of trucks may be run down the slipway without any dismantling ready to receive another vessel.

### Slipway with Radiating Arms.

A relieving slipway at Lorient in France has been constructed, in which there is a turntable at the head of the slipway with five cradle roads radiating from it, so that the longitudinal cradle carrying the vessel can be berthed on any of the radiating lines clear of the turntable; the ship is then blocked up, and the cradle is released ready for another vessel. The slipway is on a gradient of 1 in 16, and the hauling speed is 7-ft. 6-in. per min., while the power working the two main hauling drums, with a downhaul drum between, consists of a 55 b.h.p. electric motor.

### Traverser Slipways

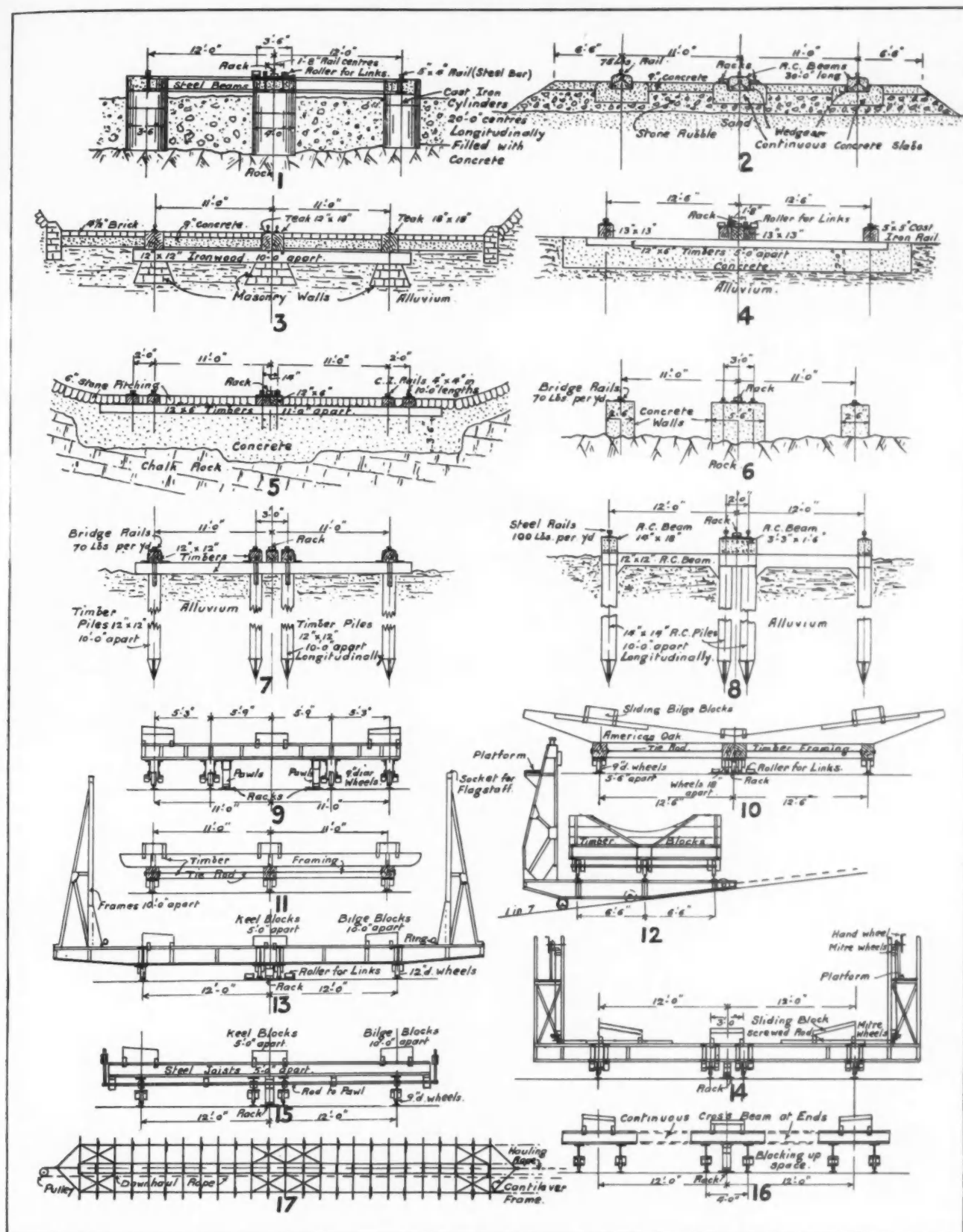
In another form of relieving slipway, the longitudinal cradle is run up over a traverser sunk in a cutting at the head of the slipway. The traverser is in separate parallel sections, and travels on rails at right angles to the slipway, so that the cradle and ship can be pulled to either side of the slipway, where the vessel is blocked up between the sections of the traverser; the bilge blocks on the cradle are slid outwards and can be turned round on pivots to clear the ship.

The traverser and cradle are then run out to the slipway, and the cradle is lowered if required for another ship.

### Rolling Friction

With regard to the rolling friction of loaded cradles on slipways, this depends upon the accuracy with which the rails have been laid, and the amount of mud on the rails. Experiments

### Ship Slipways—continued



## SHIP SLIPWAYS

have been made on several slipways, and in one the rolling friction was found to be 46.5 lbs. per ton which was equivalent to 2.08% of the weight lifted, exclusive of machinery friction, while in others the total friction, including that of the machinery amounted to from 74.7 lbs. to 87.4 lbs. per ton lifted, or 3.33 to 3.9% of the weight. The rolling friction of the cradle alone may be taken at 20 lbs. per ton, and of the loaded cradle at 40 to 60 lbs. per ton, while that of sliding links on rollers will be 20 lbs. per ton, and including the machinery and winches from 70 to 90 lbs. per ton.

The friction of directing acting hydraulic rams is from 5 to 10% of the load to be lifted, while that of machinery, winches and gearing will be about 30%. An allowance of 5% must be made on the total power required to cover the starting friction, and to overcome inertia.

### Haulage Power

The calculation of the power required to haul a ship weighing 1,415 tons, cradle 80 tons and rope 5 tons, a total of 1,500 tons up a slipway on a grade of 1 in 20, at a speed of 10-ft. per min., using a power winch and steelwire rope is as follows, viz.:—

	1500	
Pull on rope to overcome gravity	<hr/>	75.00 tons
	20	
Rolling friction of ship and cradle		
1500 x 40 lbs. =		26.78 "
		<hr/>
		101.78 "
Machinery friction, 101.78 tons x 30% =		30.53 "
		<hr/>
	Total =	132.31 "

*Ship Slipways—continued*

The total friction is 57.31 tons, and is equivalent to 85.58 lbs. per ton lifted or 3.82%.

The H.P. required on the level to overcome friction  
 $F \times V \quad 57.31 \times 10$

$= \frac{14.73}{14.73} = 38.90$  h.p. where  $F$  = total friction in tons, and  $V$  = velocity in ft. per min.

While the h.p. necessary to lift 1,500 tons on a grade of 1 in 20 at a speed of 10-ft. per minute is as follows:—

10-ft per min. =  $\frac{10}{20} = 0.5$ -ft. height raised in one minute.

h.p. =  $\frac{W \times H}{1500 \times 0.5} = 50.90$  h.p.

h.p. required on level to overcome friction

38.90

89.80

Starting friction and to overcome inertia 89.8 x 5% =

4.49

Total 94.29, say 95 h.p.

The total pull on the rope is 101.78 tons, say 106 tons, allowing for the starting pull, therefore a steel wire rope 12-in. circum. or 3.82-ins. diam. having a b.w. of 455 tons, and a safe load of 113.75 tons with a factor of safety of 4 will answer the purpose, and the winding drum will require to be 30 times the diam. of the rope or 9-ft. 6-in. diam.

**Construction of Slipways**

With regard to the construction of slipways various methods are adopted according to local conditions, the land available, the character of the subsoil, the materials available, the range of the tides, the depth of water required over the cradle blocks, and the estimated cost.

The grades for ship slipways range from 1 in 6 to 1 in 24, and of course the steeper the grade, the more power is required to raise the vessel, but the flatter the gradient, so much the better, for then there is less strain put on the ship, when the bow is on the cradle and the stern is water-borne.

The most usual gradients are from 1 in 12 to 1 in 20, and the live load to be raised including the ship and cradle varies from 5 to 6 tons per lin. ft., but may be so much as 8 to 10 tons per lin. ft.

For slipways in which the vessel is hauled longitudinally, there are at least three lines of rails with the rack to one side of the central rail, but in most cases there is a double central line of rails, with the rack placed between, as these rails carry a slightly greater load than the outer ones, amounting to 40% of the load per lin. ft., while each of the outer rails carry 30% of the load.

In some slipways all the rails are doubled, and in broadside slips the number of rails depends upon the length of the ships to be raised, and the type of cradle used.

If the slipway is in a cutting, the slopes must be clear of the longest ship, the bow and stern of which may project 10-ft. beyond the cradle.

When slipways are constructed on a rocky shore, it will be sufficient after a general clearing to the gradient required, to cut the rock in steps on the lines of the rails, say 2-ft. wide for the outer, and 3-ft. wide for the central rails, the underwater work being carried out by divers. The ways for the rails may be constructed of cement concrete in the proportions of 1-2-4 for the portion above water level, and 1-1½-3 for that below, inside timber, or metal shuttering. The rails should be fixed to the concrete by rag bolts and cleats, and the ends of the rails at each end of the slipway should be turned up to the radius of the cradle wheels.

Should there be no training jetty alongside the slipway, and no trestle framework on the sides of the cradle standing above high water level, then steel stanchions or concrete piles forming dolphins will require to be constructed, standing above high water, one on each side of the cradle, clear of the ship, at the upper and lower ends of the cradle to mark its position when submerged.

Another method of carrying out the underwater work is to place short mild steel or cast iron cylinders 3 or 4-ft. in diameter at intervals of about 10 to 15-ft. apart longitudinally under each line of rails, and fill them with 1-1½-3 cement concrete. Steel beams with fish plates and bolts, or pre-cast reinforced concrete beams can then be laid both longitudinally and transversely between the cylinders, and embedded in concrete at each support. The rails and rack may then be bolted to the top flanges of the beams.

Occasionally the underwater portion is carried out inside a cofferdam, but this is not an economical method.

In cases where the ground consists of alluvial material, it will be necessary to drive either timber or reinforced concrete piles from 10 to 15-ft. apart longitudinally under each line of rails, and fix timber or concrete cross-beams on the piles, and on top of

these the longitudinal rail and rack bearers. Two or more piles may be required at each support according to the load to be carried and the bearing capacity of the piles.

The timber rail bearers should have butt joints with steel fish-plates and bolts in lieu of spliced joints, which are liable to split. The weight of steel in straps, bolts and pile shoes in a timber-built slipway amounts to 3.25 lbs. per cub. ft. of timber, and excluding the piles to 6.5 lbs. per cub. ft.

It is always advisable to have the same type of construction where possible, throughout a slipway, to avoid unequal settlement, as this will cause breakage of the cradle wheels, due to unequal distribution of the loads on the wheels.

The rails for slipways should be flat-bottomed steel rails or bridge rails of a heavy pattern, fish bolted together at the joints. The weight of the rail should not be less than 10 lbs. per lin. yd. for each ton weight on the cradle wheels. To obtain more bearing area for the wheels, steel bar rails 4-in. by 3-in. or 5-in. by 4-in. are sometimes used, the bars having the upper edges bevelled off. They are fixed by angle cleats rivetted to them 6-ft. apart zig-zag, and attached to holding-down bolts on the slipway. The gauge of the outer rails depends upon the beam of the ship and may vary from 20 to 50-ft.

The rack may be made of cast iron or cast steel in about 6-ft. to 10-ft. lengths to avoid warping, the saw-like teeth being 6-in. wide and 6-ins. pitch by 1½ to 2-in. deep, having a bottom flange 12-in. by 1-in. thick, for bearing area, and for fixing to the holding-down bolts, at 3-ft. pitch.

When hydraulic hauling power is used, with links that have to be removed at each stroke of the ram, the rack should extend the whole length of the slipway, but with modern winches and wire rope hauling gear, it will be sufficient for it to be limited to half the length of the slipway or even less.

In some slipways in which no racks are laid, the cradle when being hauled up is held by chains attached to the cradle and to hand winches at the head of the slipway to hold the cradle while links are being removed. The sketches, Figs. 1 to 8, show cross-sections of various types of slipways that have been constructed.

**Cradles**

Cradles are constructed either of timber or mild steel framework, which vary considerably in design and are not in single lengths except for short vessels, but consist of a series of trucks closely coupled together, and mounted on cast steel single or double flanged wheels or rollers from 6 to 12 in. diam. with simple cast iron plummer blocks, from which the wheels can readily be removed by jacking up the cradle in cases of breakage. Gun-metal bearings are sometimes used to reduce friction. The framing should be diagonally braced together at each end and in the middle, each end being triangular in plan.

Some cradles are constructed with framed stanchions on one or both sides at intervals, fixed to the ends of the cross-beams, and which project above high water level when the cradle is lowered. In others, the stanchions are connected together by top gangways for operating the bilge blocks and pawls.

When it is necessary on account of the high cost to shorten the underwater portion of slipways, the cradle is arranged to be lengthened or shortened as required, and consists of a number of independent sections each from 20 to 30-ft. long. Each section is connected to the next by sliding bars, perforated with holes at intervals in the length into which pins are driven according to the extension required.

When the cradle is run down, the sections are telescoped together, and when the bow of the ship bears on the upper cradle section, the vessel is secured to it by chains or ropes, the cradle is then drawn up with the ship attached, and as each section is pulled up, the ship takes its bearing on the following sections of the cradle.

Cradles are in use that can be telescoped from 30 to 36-ft. The total weights of cradles, including the keel and bilge blocks vary with the type of construction, those constructed of timber weigh about 20 lbs. per sq. ft. of overall plan area, and steel cradles from 45 to 65 lbs. sq. ft. The plummer blocks for the wheels are fixed to the longitudinal beams, which carry cross-beams about 5-ft. apart, on which are mounted the timber keel and bilge blocks; the keel blocks are usually spaced 5-ft. apart and the bilge blocks 10-ft. Occasionally mud ploughs are fixed to the front and rear wheels of cradles, but are seldom necessary.

In some cases the bilge blocks are arranged to slide on the cross-beams by attaching angle iron cleats to them, the blocks being fixed to horizontal screwed rods having mitre wheels at the outer ends, connected to vertical rods passing up to the top gangways on each side of the cradle, and terminating in mitre wheels and hand wheels. In other cases they are pulled by ropes attached to them, and operated from the deck of the ship or from the gangways. The blocks should be low and of hard wood from 12 to 15-in. wide.

**Pawls**

The cast or wrought steel pawls are pivoted to cast iron or steel blocks fixed to the underside of the central longitudinal

### Ship Slipways—continued

cradle beams, directly over the rack, and in cradles that do not require to be partially dismantled for blocking up ships on shore, each pawl is fixed to a shaft carried across the cradle to the outside where it terminates in a counterweighted lever, or in levers operated from the top gangway.

The number of pawls required depends upon the total friction of the loaded cradle, and may amount to from 5 to 7 tons per pawl, if placed 20-ft. apart as usual. In some cases double pawls are used, placed side by side, but engaging with alternate teeth on the rack.

#### Wheels

With regard to the wheels, which may be of cast iron or steel, with single flanges, the maximum safe load that may be put on them is given by the following empirical formulæ, viz.:—

For cast iron wheels— $W = 400 \text{ lbs.} \times D \times T$ .

For cast steel wheels— $W = 600 \text{ lbs.} \times D \times T$ .

Where  $D$  = diam. of wheel or tread, and  $T$  = width of tread, both in inches. Therefore for a cast iron wheel 12-in. diam., and 2-in. tread, the safe load will be 4.2 tons, and for a cast steel wheel 6.4 tons.

If the wheels are of cast steel, and the total weight of the ship and cradle amounts to 10 tons per lin. ft. 40 % of this will come on the centre wheels = 4 tons per ft. and 30% on each of the side wheels = 3 tons per ft. Therefore the spacing of

the centre wheels will be  $\frac{6.4}{4} = 1.6\text{-ft.}$  for a single line of wheels,

and that of the side wheels  $\frac{6.4}{3} = 2.1\text{-ft.}$

The cast iron rollers of swing bridges seldom carry more than 1.5 tons per inch width of tread, while cast steel rollers are not permitted to carry more than 2 tons per inch of tread, a higher factor of safety being used to avoid the risk of breakages. The sketches, Figs. 9 to 16, illustrate cross-sections of various forms of cradles. Fig. 16 shows a suitable form of "relieving cradle," and Fig. 17 is a typical framework cradle plan.

The diameter of the drums or barrels of the winches for wire rope haulage should be 30 times the diameter of the rope, although some have been made only 20 times the diam., and pulleys on the cradle or on shore should be at least 12 times the rope diam. The ropes should always be black, that is not galvanised, and should be kept well greased or oiled, when they will last for from 25 to 30 years.

To obtain uniformity of motion in a number of separate hauling drums, it is advisable to use continuous counter-shafting with gearing rather than to have synchronised electric motors to each drum.

For hauling by wire rope a ship and cradle weighing 1,000 tons, the weights of the machinery may be so much as 10 tons for the main drum, and 5 tons for the gear wheel, and also for the down haul drum, the gearing may weigh 13 tons, and the engine 4 tons, while the total weight of the machinery may amount to 50 tons.

### Wellington Harbour, New Zealand

*Excerpts from the Annual Report of the Harbour Board for the Twelve Months ended 30th September, 1938*

**Trade of the Port.**—The record tonnages of the port last year for both cargo and shipping have been exceeded by the figures shown for the year under review. The total cargo handled through the port, inwards and outwards, amounted to 2,354,744 tons, an increase over last year of 43,668 tons, or 1.9%. The net tonnage of shipping arrivals was 4,172,595 tons, an increase of 2.0%. Imports of all classes totalled 1,318,535 tons, an increase of 23,043 tons, or 1.8%. Outward cargo of all classes totalled 591,379 tons, an increase of 3,099 tons, or 0.5%, as against 588,280 tons last year.

**Shipping.**—The total net register tonnage of trading vessels entering the port during the year (excluding 65,210 tons representing warships, lighters, private yachts, etc.), amounted to 4,172,595 tons, which is 82,288 tons greater than last year.

Last year the tonnage of cruise and tourist ships calling at Wellington was 59,446 net tons; this year the tonnage is 134,164.

For comparison with those ports combining the arrivals and departures, the total net register tonnage of trading vessels that arrived and departed from and to overseas and coastal ports during the year was 8,045,220 tons.

**Financial Results.**—Receipts for the year were £628,241 7s. 0d., an increase of £69,491 17s. 1d., and the Expenditure £616,876 3s. 3d., an increase of £69,298 15s. 6d. The surplus on the year's working was £11,365 3s. 9d., compared with £11,172 2s. 2d. last year.

**Port Development.**—During the year the Board has had under consideration the question of providing for the future trade of

the port by increasing the present berthage, storage, and cargo-handling facilities. In many instances the older sheds, particularly those on the Queen's Wharf, have become too small for the purpose for which they were built. This condition has been caused not only on account of the increased volume of cargo to be handled, but also by the change that has come about in recent years through smaller individual consignments arriving with more varied markings, and the use of cartons and fragile and lighter packings for inward and outward goods. There has also been a tendency for more firms to use the wharf sheds as warehouses and not as transit sheds. If such facilities for distribution are required by importers then, as in many other overseas ports, this work should be done in stores adjacent to the wharves, so that proper use can be made of the Board's transit stores and delays avoided to shipping requiring a quick turn-round. To this problem has been added the traffic question, as many of the Board's connecting breastworks are not sufficiently wide to carry the heavy vehicular goods traffic to and from its stores, together with the Board's own transshipping service involving the use of a large number of tractors and trailers. To some extent, this can be met by increasing the width of the connecting wharf breastworks, but even then, without a proper restriction of public and private passenger vehicles desiring to use the wharves, the position may not be satisfactory. In many overseas ports this taxi traffic is not permitted within the gates of the port authority, but, on the Wellington wharves, only on the arrival or departure of vessels is any restriction made at any particular wharf. These wharf traffic problems are made more difficult by reason of the close proximity of the main wharves and approaches to the centre of the commercial portion of the City of Wellington.

So that a survey can be made and a comprehensive report prepared for the Board's consideration of the harbour works to be carried out in the port to meet present and future requirements of import and export trade and shipping, the Board set up a special committee, called the "Port Development Committee," consisting of Messrs. C. M. Turrell (Chairman), Chapman, Fitzherbert, London, McGowan, Barrer, Price, and Sir Charles Norwood. This Committee has had several meetings, but its final report has not yet been made.

### South Jersey (U.S.A.) Port Commission

The 13th Annual Report for the year 1938, of the South Jersey Port Commission, commences with a statement of Jurisdiction, as follows:—

The Commission exercises authority over the South Jersey Port District, created in 1926, embracing the counties of Mercer, Burlington, Camden, Gloucester, Salem, Cumberland and Cape May. Its easterly and southerly boundaries run along the tidal and navigable waters of the Delaware River and Bay, and on the ocean side from Cape May Point to Great Egg Harbour Inlet, having in all a sea frontage of approximately 206 miles. The Port District comprises 1,732,614 acres of land and 274,772 acres of water, a total of 2,007,386 acres, or more than one-third of the total area of the State of New Jersey.

The water-borne commerce in the District for the year 1937 amounted to 6,817,467 tons, with an estimated value of \$122,539,298, an increase of approximately 6% on the figure for the preceding year.

Camden and Trenton are the leading ports of the District, each having modern public terminals, equipped with all the necessary facilities for handling goods in import or export, inter-coastal, coastwise and domestic traffic, and movement to and from terminals by rail or truck. At Camden, the public terminals are operated by the South Jersey Port Commission. At Trenton, there is municipal operation.

The Port Commission consists of three members, with Mr. Albert C. Middleton as Chairman. The General Manager is Mr. J. Alexander Crothers.

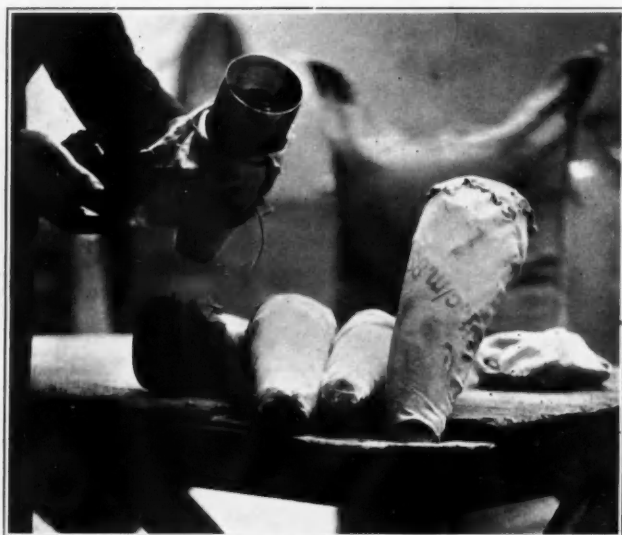
### Fumigation Plant at Southampton Docks.

Scientific methods of dealing with grub infestation of dried fruit are being adopted by the Southern Railway at Southampton Docks. By the installation of an entirely new type of fumigation plant in a special warehouse, 24,500 boxes of dried fruit can be separately fumigated with a vapourised mixture of ethylene oxide, which destroys all stages of development of insect life, including the egg. The warehouse contains seven chambers, each capable of storing 3,500 boxes of dried fruit, and fumigation is effected by fanning the fumigant into the chambers through a system of pipes at a pressure of 13 lbs. per sq. in., and later withdrawing it by the same means. The mixture of ethylene oxide which is used has exceptionally high penetrating qualities, and whilst it effectively eradicates the pest, larvæ and eggs, it does not affect the colour or quality of the fruit in any way, nor does it leave a residual odour or taste in materials with which it has been in contact.

## Commodity Packings and Wrappings

By A. G. THOMPSON

A perusal of H.M. Customs "Bill A" gives some indication of the infinite variety of commodities which have to be handled at the various ports. Bulk cargoes such as grain, coal and oil can be discharged by quick mechanical methods, but general



(Photo by courtesy of the P.L.A.).

Civet is packed in buffalo horns with a covering of sacking

cargoes consisting of units of all shapes, weights and sizes present problems which have been solved only by the experience of years of practice. Beyond an abbreviation showing whether the goods are in cases, bundles or barrels, there is little indication of the packings employed. One is reminded of the old question, "which is the heavier, a pound of feathers or a pound of lead?" The lead is certainly much easier to handle as it is shipped in convenient ingots or bars which can be stowed very easily and take up very little cubic space. The feathers are in bales and "weigh light," but take up a great deal of cargo and shed space. Commodities falling under H.M. Customs' classification, "Food, Drink and Tobacco," account for many of the varied descriptions of packages and wrappings which pass through the transit sheds and warehouses of a port. Cheese from Canada is packed in what resemble hat boxes, known to the dockers as "bowlers," while New Zealand cheeses are packed in pairs in crates. Cereal foods of well-known proprietary brands are shipped from Canada and the United States in cardboard cartons. Biscuits are generally easier to handle as the usual practice adopted for export purposes is to pack the square tins into containers fitted with eyes at each corner, thus facilitating loading on board.

Sugar generally arrives in two-hundredweight bags which cannot, of course, be discharged if it is raining. Cuban sugar, known as jaggery, is packed in mats of woven straw. Tea is shipped in plywood chests or half chests and coffee in frazils—oblong packages made of straw matting.

Bananas require very careful handling both at the point of loading and at the point of discharge. A few years ago bananas were mostly packed in crates, but it is now usual to ship them by stems or bunches. In some instances stems are wrapped in paper and covered by a loosely-sewn cover of leaves, the final result resembling a large cocoon. Apples arrive in barrels and cases, some from Australia being packed in hardwood boxes which, while adding to the gross weight, are nevertheless economical, as softwood timber has to be imported into Australia. The orange box is perhaps the most familiar of all containers, this oblong package with compartments having varied very little over a long period of years. Soft fruits, such as plums, apricots and peaches are usually packed in trays or half-trays. Pears are sometimes packed in trays, two or three of which are strapped together with iron bands; this method of strapping is still used to a certain extent for tomatoes from the Canary Islands, but these now mainly arrive in small basket-shape packages known in the trade as "boats." Early vegetables, such as runner beans, arrive in chip baskets. Onions are either packed in boxes similar to orange boxes or shipped in fine mesh net sacks which require careful handling as they are none too strong. The methods of packing nuts vary considerably, Barcelonas being shipped in bags, walnuts and other kernels in wooden cases, cocoanuts in coarse nets or sacks, while almonds from North Africa and Spain are packed in serons—coarse straw matting bags. Spices are another class of goods with their own peculiar packing. Nutmegs from Singapore are packed in mahogany boxes painted black at the

edge; cloves from Penang are in boxes covered in sacking while those from Zanzibar are contained in matting. Cinnamon bark is rolled into "quills" 18-in. long and packed closely together in bales 40-in. long.

Wines, beers and spirits account for an interesting collection of barrels, bewildering to the layman who probably knows that port is in pipes of about 115 gallons, sherry in butts of about 108 gallons and rum in puncheons of about 100 gallons. Wine and brandy casks include hogsheads of about 56 gallons, third casks, quarter casks and octaves. Until recently empty pipes of port were taken to pieces and the staves packed tightly together in a bundle known as a shook. These shook were shipped back to Portugal for re-coopering, but of late, owing to a shortage of barrels due to the Spanish Civil War, Portugal has permitted the importation of empty pipes. Sherry butts are not returnable and are retained for holding whisky. Brandy casks manufactured in South Africa are known as "Deutchers." Beer is imported under pressure in metal containers and in crates of bottles.

Some years ago a triple butt of sherry was imported from Spain. This butt was 5½-ft. long with a circumference at the centre of 12½-ft. and had a head diameter of 3½-ft. It contained 344 gallons of Olorosa Sherry—sufficient to fill 2,000 bottles. This triple butt had laid in a bodega at Jerez for 30 years during which time the wine had impregnated the wood to a depth of nearly ½-in. Despite the enormous size it was not, however, as big as two butts imported for the Great Exhibition of 1851. Each of these contained 2,200 gallons and had a circumference of 30½-ft.

Tobacco, of which over 100 varieties of leaf are imported into the United Kingdom from many parts of the world, is packed in hogsheads, tierces, barrels, cases and bales. A hogshead, which weighs over 900 lbs. net, may be made of poor quality softwood or of good quality oak staves.

Drugs, originating as they do in many remote parts of the world, have many forms of native packings. Sarsaparilla roots from Honduras, for example, are packed in cowhides as is raw Balsam from South America, though sometimes the latter is put into petrol cans. Iodine from Iquique is contained in small kegs wrapped in goat skins. Aloes arrive in a variety of packings such as earthenware jugs, crude native pots and pans, in boxed



(Photo by courtesy of the P.L.A.).

The staves of empty port pipes packed in shook for return to Portugal

petrol cans and in monkey skins packed in second-hand cases. Civet, a secretion of the Abyssinian cat, used in scent manufacture, is contained in water buffalo horns wrapped in sacking. Certain gums are packed in skins and serons, while indigo from Indo-China is packed in bullock hides with the hair inside. Ivory is usually wrapped in gunny, although tusks confiscated for offences against the game laws are shipped by the Crown Agents for the Colonies in galvanised iron tanks.

### Commodity Packings and Wrappings—continued

Animal oils, such as seal and cod liver, and vegetable oils, olive and ground nut, are shipped in casks or metal drums. Metal drums are also used for resin, paints and certain acids.

Coir yarn, sisal, cotton and wool are shipped in compressed bales. Egyptian cotton comes in bales of 750 lbs. and American cotton in pressed bales of 500 lbs., the latter being to meet the

Mention must also be made of some of the heavier imports and exports which have to be dealt with by Dock undertakings. Furniture is mostly door-to-door delivery by containers; pianos are boxed in substantial wooden cases. Cement is packed in paper bags and cable is wound on drums which are then boarded round the rim.



An assorted collection of drugs in their packed state as they arrive from ships—bags, bales, cases, etc. The boxes (lower left) contain Singapore Dragon's Blood; the cases just beyond contain Gum Benjamin; alongside these boxes are bags of Carthagena Ipecacuanha Root. The labourer seen to the left is loading a bale of Matto Grosso (Brazil) Ipecacuanha Root.

(Photo by courtesy of the P.L.A.).

requirements of freight charges being levied on the cubic capacity rather than on the weight. "Colonial" wool is banded with hoop iron and bales of "Puntas" or South American wool, which is under greater pressure and weigh from 7 to 12 cwt., each, are looped with steel bands joined by "laps." The bales themselves are made of gunny which is used again for sacking and packing while the bands are used for the manufacture of safety razor blades.

Raw silk is in skeins, a bundle of which is known as a "book." These "books" are wrapped in a calico "shirt," which in turn is protected by greaseproof paper. The bale has an outer wrapping of grass matting, the whole measuring about 3 ft. square and 15-in. thick. Bales of Chinese silk contain 15 books, while those of Japanese silk contain 29 books.

### Improvements to Whitehaven Harbour

The following particulars of improvements recently effected at Whitehaven Harbour have been courteously supplied by the Consulting Engineers.

The main work carried out has been the removal of the curved invert to the floor of the Queen's Dock entrance, and the replacement of the old wooden hand-operated gate by steel gates, operated by power.

In carrying out the former work, the existing floor where the curved invert existed was excavated to 5-ft. below the sill level, and replaced by heavy reinforced concrete beams, over lengths of 15-ft. and 30-ft. respectively inside and outside the dock. The beams were carried well under the shoulders of the walls.

In view of the known existence of springs under this floor, it was heavily grouted with cement, after steel sheet piling had been driven both inside and outside the dock to form a cut-off. This sheet piling was extended for the full length of that side of the dock which comprises the Timber Quay, and the area between it and the wall was sealed with concrete.

The width of the dock entrance between the coping of the walls is 50-ft., and this now reduces to 44-ft. 3-in. at sill level. The curved invert previously extended above the sill for a height of approximately 4-ft., so that for the larger-sized vessels the effect has been to give this extra depth, allowing their use of the dock for a greater range of tides, and possibly vessels of greater draught at the higher tides.

Work on this reconstruction began in July, 1938, and, owing to some delay in the delivery of the gates, the steel cofferdam could not be removed until their erection was completed, the dock being re-opened on May 4th, 1939. In the meantime, to enable the Timber Quay to be used by vessels of maximum draught, it was fendered with pitch pine and the quay width widened by 1-ft. 9-in. by cantilevering out with reinforced concrete, owing to it not being possible to drive the steel sheet piling closer than 4-ft. from the toe of the wall.

It is now possible to dredge safely along the berthing length of this wall to about a foot above the sill level.

Plywood is in bundles ranging up to 5-ft. wide and 17-ft. long. Sometimes the edges are protected by pieces of softwood bound round with wire, while at other times the whole bundle is protected by a woven strip-wood cover or by brown paper, or the whole contained in a stout cardboard box. Cardboard, wood pulp and millboard is in bales, and newsprint in reels ready for the printers' machines.

Bars and ingots of metals, such as gold, silver, copper, lead and aluminium are as easy to handle as bricks. Quicksilver from Spain is contained in steel bottles each weighing about 8 lbs.

Other out-of-the-way cargoes are live eels in tanks, live goldfish in metal carboys, oxygen in cylinders and shells from the Great Barrier Reef in crude woven baskets or in tins.

The steel gates have a span between the heel posts of 51-ft. 10-in., and the distance of the sill from this line to its apex is 9-ft. 2½-in. The length between the top and bottom decks of the gates is 22-ft. 3-in., and the superstructure above, carrying a gangway, extends for 12-ft. 11½-in. to its floor level. There are two sluice openings in each gate, each 4-ft. by 1-ft. 3½-in., immediately over each other, and they are operated by 1 hand-control sluice gear-wheel from a pedestal on the gangway.

The control of the gates has special features, in that the gates are moved by an operating arm moving on a rack some 6-ft. below the top of the dock walls, and there is a patent adjustable stop which locks this arm rigidly in position once the gates are closed.

The movement is carried out by two 8-h.p. motors, working at 420 volts D.C., using only 5 to 6 amperes of current, the time taken for opening being 2 minutes 20 seconds. Safety devices of a slipping clutch and a fluid coupling have been introduced, and there is an emergency hand-control gear in the event of a breakdown of the motors; two men operating the latter take 11½ minutes to open the gates.

The instruments for control are housed in a single kiosk on the north side of the gates, from which the man operating the switches has a good view of the gates.

Other work carried out at the same time has been reconstruction of the extremity of the Bulwark to facilitate entry to the Inner Harbour, en route for the Queen's Dock, and tying back with 2½-in. steel rods to a reinforced concrete beam the portion of the dock wall opposite the Harbour Commissioners' Office, which was unsafe. The former work involved shortening the wall for 8-ft., and reducing the width at the extremity to one-half by sloping the remaining portion approximately 1½ to 1; the foundation was piled with steel sheet piling, and fendering erected, thus consolidating the whole and preventing any further tendency of the wall and its foundations to crack and sink into the fairway.

Sir Murdoch MacDonald and Partners were Consulting Engineers for the work, Messrs. Christiani and Nielsen carried out the masonry work, and Messrs. Ransomes and Rapier constructed and erected the gates.

## Port of London Registration Committee

Excerpts from Annual Report for the Year ended  
31st December, 1938

### Number of Registered Port Workers

The policy of limiting the number of Registered Port Workers to the approximate labour requirements of the port has remained unchanged, and during 1938 the total number of Registrations cancelled exceeded by 609 the total number of new Registrations and re-admissions. On the 31st December, 1938, there were 33,774 Registered Port Workers in London, as against 34,383 at the end of the previous year.

### Constitution of the Committee

The only change in the constitution of the Committee which occurred during the year was the retirement of Mr. E. F. Farrow as Representative of the Association of Public Wharfingers in the Port of London, and the appointment of Mr. R. H. S. Woodgate as his successor. Mr. Farrow had been a member of the London Registration Committee since April, 1931, and his long experience of the port was of invaluable assistance to the Committee.

### Employment and Unemployment Position of Registered Port Workers

In the absence of a daily record of employment in the Port of London, the only available method of estimating the employment position of the Registered men is by means of the statistics relating to the daily average unemployment for each month furnished by the Ministry of Labour. A statement based on these statistics follows:—

#### Daily Average of Registered Men Unemployed.

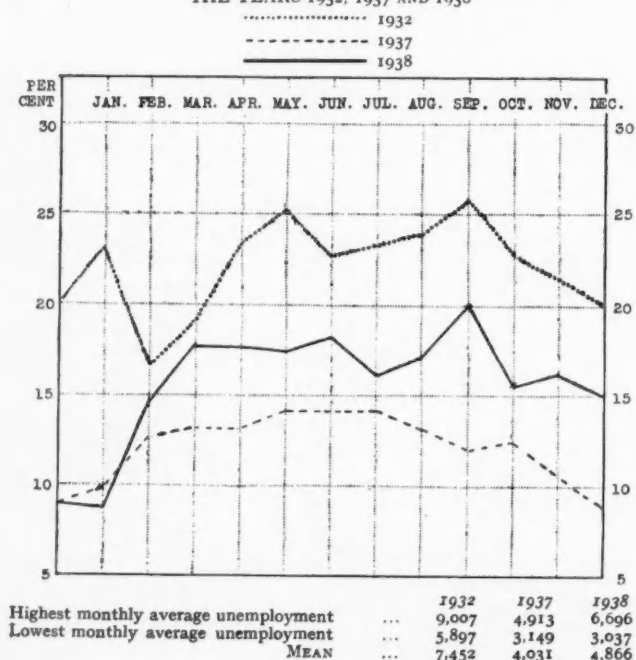
January, 3,037; February, 5,060; March, 6,055; April, 6,033; May, 5,949; June, 6,205; July, 5,428; August, 5,784; September, 6,696; October, 5,221; November, 5,453; December, 5,076. (The average total register for the year 1938 was 33,979).

The Committee's decision to divide the Register of Port Workers into four main sections at the annual Exchange of Registration Books in July, 1938, has enabled a statement to be prepared, indicating separately the average daily unemployment in each section for the last five months of the year.

Section	Number in Section on 31.12.38	Average Daily Unemployment				
		Aug.	Sept.	Oct.	Nov.	Dec.
Ocean Shipowners' Tally Clerks ... ..	1,295	112	158	125	145	140
Lightermen and Barge-men ... ..	3,076	324	378	357	372	375
Stevedores ... ..	4,326	892	1,132	804	811	966
All other Port Workers	25,077	4,456	5,028	3,935	4,125	3,595

The graph below illustrates the monthly percentage of proved unemployment of Registered Port Workers to the total number on the Register for the years 1937 and 1938, and for purposes

GRAPH SHOWING THE PERCENTAGE OF PROVED UNEMPLOYMENT TO TOTAL REGISTER OF PORT WORKERS IN LONDON FOR THE YEARS 1932, 1937 AND 1938



of comparison, the year 1932. (Prior to 1932, the statistics furnished by the Ministry of Labour were restricted to one week per month). On the assumption, therefore, that a decrease in the monthly average of unemployment indicates a corresponding increase in the number obtaining work, an examination of the graph will show that the employment position of London Registered Port Workers in 1938, though not so good as in the previous year, has greatly improved since 1932.

### Conclusion

In concluding their Report, the Committee submit that the undoubted value of the regularisation of Port Labour in protecting the employment interests of the Registered men in London was clearly emphasised during the past year. They regard it as significant that, despite the shrinkage in trade due to international uncertainty, the average level of employment, though slightly below that of 1937, was much higher than in any other previous year for which comparable figures are available.

It is nevertheless a matter for further examination that, notwithstanding the increased unemployment amongst Registered Port Workers during the past 12 months an apparently excessive number of non-registered men were engaged more or less constantly in every dock area. This anomaly is believed to have been largely due to the immobility of labour, but the Committee are hopeful that greater use will be made of the Port Workers' Offices for effecting additional labour engagements at short notice. In acknowledging, therefore, the valuable assistance rendered by Port Employees and Trade Unions associated with the work of Port Registration in London, the Committee desire to stress the necessity for a continuance of that close co-operation so essential to the future progress of the scheme.

On the administrative side, the work carried out by the Secretary and his staff during the past year has been exceptionally heavy, and we have pleasure in recording our appreciation of the services rendered by Mr. W. E. Thomas, Secretary, Mr. A. L. Nicholson, his Assistant, and the staff, whose capable handling of the many problems has enabled the work of the Committee to proceed efficiently and smoothly.

The Report is signed by W. L. Wrightson and T. W. Condon (Joint Chairmen), and W. E. Thomas, Secretary.

## River Pollution

The Report of the Water Pollution Research Board for the year ended 30th June, 1938, recently issued by the Department of Scientific and Industrial Research (H.M. Stationery Office, 1s. 0d. net), contains much of importance as regards the contamination of liquids used for human consumption, but its chief interest for readers of this Journal lies in a reference to, and summary of, the findings in the River Mersey Investigation, which was the subject of editorial comment in our issue of June, 1938. As the investigation established a very important fact bearing on river conservancy work, it may be well to give the extract from the report, as follows:—

"The investigation on the River Mersey, which was begun in 1933, and occupied about four years, has been completed, and a comprehensive special report has been published as Water Pollution Research Technical Paper No. 7. A full summary of the experiments, observations, and conclusions, is included in the present Report of the Board. The work was undertaken at the request of the Merseyside Local Authorities, the Mersey Docks and Harbour Board, and other local interests, who agreed to meet the whole of the cost. Its object was to determine the effect of the discharge of crude sewage into the Estuary on the amount and hardness of the estuarine deposits. This problem, which was obviously one of considerable importance to the Authorities responsible for the conservancy of the river, and for the disposal of sewage of the Merseyside towns, had for many years been the subject of much local controversy. The investigation, which cost about £26,000, has been eminently successful, in that it has given a definite answer to the difficult question asked in the terms of reference. It has led to the conclusion that the crude sewage discharged into the Estuary of the River Mersey has no appreciable effect on the amount and hardness of the deposits in the Estuary."

### Retirement of Port Authority Committee Chairman.

The Port of London Authority have placed on record an expression of their high appreciation of the valuable services rendered by Mr. J. D. Gilbert, D.L., J.P., formerly M.P. for West Newington and Central Southwark, as a Member of the Authority for 26 years, Chairman of the Stores Committee for nearly 15 years, and Chairman of the River Committee for four years; and of their great regret at his recent resignation. Mr. Gilbert's public service has covered a wide field, but he has had a particularly active interest in the Thames and the Port of London as a Member of the Port of London Authority, the Thames Conservancy and the London County Council.